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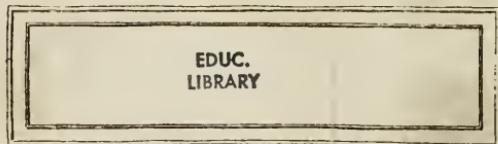
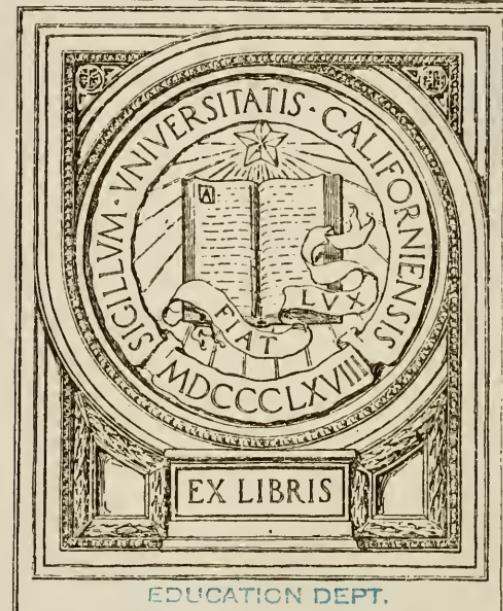


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# SPELLING ABILITY

## ITS MEASUREMENT AND DISTRIBUTION

B. R. BUCKINGHAM, PH.D.

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## SPELLING ABILITY—ITS MEASUREMENT AND DISTRIBUTION

### § 1. *Introduction*

The purpose of this dissertation is to derive a scale for the measurement of spelling ability and to show some of its uses and applications. Such a purpose relates itself closely to a general movement, which is now well under way, and which aims to place in our hands the means of stating with something approaching the precision of objective measurement the amounts of each school ability possessed by an individual or a group. We received not long ago a scale for Handwriting (Thorndike, E. L., 1910) and still more recently a scale for English Composition (Hillegas, Milo B., 1912). The former consists in the use of selected specimens of handwriting each of which has been evaluated; the latter consists of a similar series of English compositions. It will be noticed that some of the conditions of objective measurement are met. We measure given specimens of handwriting by comparing them with actual samples of handwriting of known value. We determine the quality of English composition by a like comparison with samples of actual English writing of known value.

It seems clear, therefore, that if we are to measure ability in spelling at all it will be by reference to an evaluated standard or sample of spelling. If we can arrange a series of words on a linear projection in such a way that the words from the low end to the high end are placed at equal intervals determined by the difficulty of each word, and if we can determine a zero-point such that failure to spell the word fixed at that point under the required conditions indicates *absence* of spelling ability, then we shall have constructed a scale by which we may measure the spelling ability of an individual, or by which we may through suitable tests determine the difficulty of any word in the language. Since the spelling of individuals may

thus be rated, the spelling of classes, of schools, and of school systems may likewise be rated.

It may be said that we have always rated pupils in spelling; and that schools and school systems have likewise been rated. Such is indeed the case. But there has always been a lack of precision in these ratings due to the inequality of the units employed. Dr. Rice (Rice, '97), for example, in testing the pupils in 4th to 8th grades in twenty-one school systems used a list of words containing among others: *disappoint, necessary, changeable, better, because, picture*. The method of rating pupils was the usual one of deducting from 100 per cent the same per cent for each word. That is, all words were taken as equal measures of spelling ability. A moment's attention to the six words mentioned will lead us to suspect that this is not a true assumption; and an actual test of a group of 5th-year children with these words shows that our suspicion is correct. In such a test mistakes were made as follows:

disappoint, 37  
necessary, 42  
changeable, 42  
better, 3  
because, 1  
picture, 0 (Thorndike, '04, p. 8)

To give these words equal weight in any test is to make inaccurate most of the conclusions based upon it. A pupil who spells all or nearly all of the list is a much better speller than the figures show; for he has probably spelled not only all the easy words but also many of the hard ones. On the other hand, a pupil who misses most of the words is a much poorer speller than his rating indicates because he has probably failed to spell all the hard words as well as most of the easy ones.

Nor is this list of Dr. Rice's at all unusual. Cornman used the same list (Cornman, '02). Both used a composition test where pupils were rated according to the per cent of their correctly spelled words among the total number of words in a written exercise. Cornman also used a test in which school

children were required to write "as many words as they could" in 15 minutes. Of course in the composition test and in the 15-minute test no two children wrote the same words. Moreover, the words written by each child must have varied widely in difficulty. The result for the 15-minute test, according to Cornman's best table, is as follows:

SCHOOL YEAR	MEDIAN PERCENTAGE	AVERAGE VARIATION
8th	97.9	.60
7th	96.2	.50
6th	95.2	.33
5th <sup>a</sup>	94.3	.36
5th <sup>b</sup>	94.3	.10
4th <sup>a</sup>	94.7	.66
4th <sup>b</sup>	93.7	.96
3d <sup>a</sup>	93.5	.23
3d <sup>b</sup>	93.0	1.43

One conclusion from this is that "pupils of the elementary school increase regularly from grade to grade in accuracy of spelling." This might almost be taken for granted. But in answer to the question, "How much does one grade surpass another?" the figures afford no information. Obviously from all we know of the elementary school, the difference between eighth-grade ability and low third-grade ability in spelling is far greater than the figures 97.9 and 93 indicate.

Similarly the Composition Tests of Rice and Cornman are misleading when used to indicate spelling ability. According to the series of Composition Tests of the latter, 8th-year children on the average spelled 99.5 per cent of their words correctly, and children of the first half of the 3d year spelled 93.2 per cent correctly. The author draws conclusions from his figures as to the progress of each grade for the school year, as to the progress of the school and as to the effect of the suspension of instruction in spelling. Since in the series of eight tests the children wrote various kinds of lessons—Geography, History, Science, Language, Composition—each with its own peculiar words, and since each pupil used his own individual vocabulary, we cannot escape the conviction that while these figures may be suggestive of progress, or of the effect of change in method, or of grade differences, they are nothing more than suggestive.

They leave unanswered the questions,—How much progress? How large an effect? How great a difference? As we grow more and more accustomed to quantitative thinking in our educational work, we feel that these are precisely the questions that we ought in some way to be able to answer.

These studies of spelling made by Cornman and Rice remain the most important statistical treatment of the subject. That they have not great value it would be presumptuous even to imply. Their results are in a general sense true. To a certain extent their lists, even though made up of words of various and undetermined difficulty, may be used, especially for comparative purposes, as a total measuring device. They do, however, undoubtedly suffer through lack of precision, while their statements of *amounts* of difference are in general misleading.

The same thing may be said of later investigations. For example, Wallin's tables and his conclusions from them as to the transfer of spelling efficiency and its relation to age, grade, and sex are subject to the same limitations (Wallin, '11). Pearson's "Experimental Studies in the Teaching of Spelling" (Pearson, '12), however, shows a recognition of the difficulty, although it offers no remedy. In his treatment of the relative values of the "together-method" and the "separate-method" of teaching homonyms this author says: "Owing to the inequality of the units of measurements, it is impossible to determine accurately from Table IV whether the together-method is superior to the separate-method. One cannot decide, for example, positively whether an improvement from 3.78 errors (median of a class) to 2.86 errors is greater or less than an improvement from 5.6 errors to 3.3 errors." If, however, the words used could have been evaluated through an independent test by reference to a scientifically constructed scale, the "inequality of the units of measurement" would have disappeared. The further treatment of the foreshortening of the opportunity for improvement due to high initial performance is quite another matter.

It will be clearly seen from the foregoing that in practically all work which has attempted to present the spelling situation statistically it is assumed as fundamental that one error equals

another and that to spell one word is the same as to spell another word.

It will therefore be profitable to seek in this field as others have sought in other fields to devise an instrument which will more accurately measure that of which we are so often called upon to give a quantitative statement.

### § 2. *Limitations*

The study here attempted is confined to the elementary school entirely. It covers the grades from the third to the eighth, both inclusive. The schools tested are all located in or near New York City. The cosmopolitan character of the population of the metropolitan area makes it extremely unlikely that results of a materially different character would have been obtained by testing schools in various sections of the country.

It is believed that these schools are fairly typical within the limits of the area chosen. School I is a private school of high class whose pupils are mostly American born and from good homes. All the other schools are public schools. School II is in a German section of rather low class. School III is in a better neighborhood, foreigners predominating. School IV is in an Italian section. It has long had the benefit of high-class supervision and organization. School V is again predominantly American. It is located outside of the city system. School VI is in a good residential section of the city. School VII is a large school, most of whose pupils are of foreign parentage. Territorially, two schools are in Manhattan, one in the Bronx, one in Brooklyn, and two in Queens, while one is outside of the city entirely.

In all 8,791 pupils were tested. It is thought that this is a sufficient number for practical purposes. In fact it was found that the returns from each additional school after the first three or four made almost no change in the results. It is probable that greatly increasing the number of pupils tested would have afforded little compensation for the additional labor. It has seemed wiser to limit the number to a moderate one and to spend considerable effort in making the statistical analysis as complete as possible.

### § 3. *The Original List*

The preliminary testing was made with a list of 270 words. It will be called "The Original List." It was itself selected from a much larger list of graded words used by the author of this dissertation in his own school, the same having been secured by taking from five of the popular Spelling Books now in use a vocabulary of 5,000 words agreed upon by two or more of the books. The principles of selection for these 270 words were: (1) that all of them should be sufficiently common to be in the speaking vocabulary of third-grade children; and (2) that the spelling difficulty of many of them should be great enough to test the ability of eighth-grade children. As a matter of fact, the selection did not consist of 270 words at first. The list grew to that number only after the chosen words were put into sentences. The necessary helping words then swelled the total to the number given.

The sentences were dictated during the fall term of 1910 to schools I and II. They were given to grades 3 to 8 in School II, and to grades 4 to 7 in School I. Their dictation consumed several periods for every class. The following are the sentences:

*There were forty birds on the bridge. Do not go until I come. On Wednesday an umbrella was found. Whose pencil is this? My uncle gave me a banana. The butcher gave the hungry dog a piece of meat. My answer is ninety. For a nickel I bought an orange, a peach, and a pear. A dollar is not too much money for so beautiful a picture. Learn to do right because it is right. The chicken ran across the road. The janitor sweeps every Tuesday afternoon. It is wrong to steal even a penny. It would be easy to watch for your cousin from the parlor window. It is the hour for recess. Smoke was coming out of their chimney. One summer evening my neighbor came into my kitchen. I did not know he was coming that night. To whom does this pair of scissors belong? I am almost sure they belong to the tailor. The doctor thought he ought to go at once. His bicycle was against the fence. But a carriage was stopping in front of his office. His friend was already beginning to speak to him. He said the soldier should have medicine this minute. Pshaw, there was neither a monkey nor an elephant at the circus. Get some*

*coffee, sugar, and soap at the grocery store. The soldier dropped his sword and pistol. Jack had a whistle and nineteen nails in his pocket. The pretty fairy had a saucy tongue. One day in February people saw a sleigh pass through the avenue. Shoes are made of leather and a little iron. A week from to-day there will be a dance. Cut up a tomato and an onion together. In my garden I shall raise cabbage instead of beets. The saucer was round like a circle. Make no noise; do not whisper or laugh. Nobody should be without a handkerchief. A straight line has length only. We shall believe the truth. We have another piano at our school. Is it true that there was grease on the towel? This animal has a large mouth. It is not often cold enough for the ocean to freeze. Guess what made me sneeze. Choose which one of the pigeons you like. Touch the button with your thumb. The American Indian had corn and tobacco. I have written the whole alphabet. I wear a number thirteen collar. If the men quarrel, telephone me or send a telegram. Our arithmetic lesson is in addition. We also subtract. A handful of corn was all I had for supper. What is the title of the story? Did you hear the thunder last night? I am tying up my shoe. A basin of water sat on the table. That sentence has twelve words in it.*

Those who dictated the sentences were directed to read them in whole or in part as many times as seemed necessary to secure their complete comprehension. Pupils were therefore not required to retain in mind a long series of words.

In rating the papers only the words printed in italics were considered. If a word occurred twice it was regarded only the first time it appeared. Omitted and illegible words were classed as wrong. All the papers here as well as elsewhere throughout this study were rated by the same person. They were rated from two points of view: (1) as to the number of times each word was correctly spelled, and (2) as to the per cent of the entire number of words each pupil spelled correctly. The former point of view is the only one to which attention is now directed.

Table I is a sampling from the entire 270 words as given to schools I and II. At School I the grammar-school course is completed in seven years. It therefore has no 8th grade. As stated above, the test was not given to the 3d grade in this school.

TABLE I  
FIGURES INDICATE PER CENT CORRECT

Table reads: "across" was spelled correctly in the 3d grade of School II by 17% of the pupils; in the 4th grade of School I by 60% of the pupils, and of School II by 40% of the pupils, etc.

GRADE.....	3d	4th		5th		6th		7th		8th
		SCHOOL.....	II	I	II	I	II	I	II	
across.....	17	60	40	76	58	90	79	98	87	93
addition.....	2	38	26	60	28	76	45	94	76	83
almost.....	16	62	41	73	65	88	75	80	81	87
alphabet.....	25	13	1	63	12	40	46	82	43	68
arithmetic.....	27	89	53	100	72	96	92	100	97	98
bridge.....	29	59	42	87	52	98	85	100	94	97
button.....	14	50	35	70	49	77	63	84	62	83
choose.....	6	25	10	37	31	62	37	67	55	65
day.....	97	100	98	96	100	100	99	100	100	100
guess.....	6	29	17	67	30	77	50	82	66	85
handful.....	36	47	33	46	19	76	33	75	63	57
pshaw.....	1	4	6	29	6	46	5	31	31	18
tomato.....	34	83	49	67	43	74	48	79	32	38
too.....	0	10	3	17	4	26	7	63	22	27
whose.....	17	49	15	40	29	47	10	57	59	66

#### § 4. *The Selected List*

On the basis of the results for the Original List, a group of 100 words was chosen. It is here called the "Selected List." In Table I are shown 15 words from the Original List. The word "across" is typical of the words taken for the Selected List. Since 17 per cent of the 3d-grade children spelled it correctly, it was not so difficult in that grade as to offer no test of ability. It showed a steady increase throughout the following grades but did not reach so high a figure in the highest grades as to prevent its being a test of ability there. "Almost" and "button" were chosen for the same reason. "Addition" was not taken because it was too hard for 3d-graders. Only 2 per cent wrote it correctly. So small a number as two in a hundred might get it right by chance. Practically, therefore, the word is a zero word for the 3d grade; and such a word does not test ability. There may be—and in a given grade there certainly would be—wide differences in spelling ability, but such a word

will not show them. "Alphabet" was rejected because though high in the 3d grade it was very low in the 4th, suggesting that in School II it was a word that the children had recently studied. "Arithmetic" was not taken because from the 6th grade on it offered practically no difficulty. As in the case of a word rated at zero or nearly zero, so in the case of a word rated at 100 or nearly 100, there is no test. Good spellers and poor spellers so far as the particular word is concerned behave exactly alike. "Bridge" was not taken for the same reason. "Choose" was too hard in the 3d grade. "Day" was too easy everywhere. In fact "day" is a type of word such that we may almost be warranted in saying that one who cannot spell it has no spelling ability. "Guess" was taken because although it is very seldom spelled correctly in the 3d grade, its form is so peculiar that the few who did write it correctly probably knew how to spell it, i.e., did not get it right by chance. "Handful" is a type of word taken because although it shows no regular increase from grade to grade it offers a real test for every grade. The later results in other schools, however, showed that its irregularity is not accidental in schools I and II but is a peculiarity of the word itself. "Pshaw" is a familiar word to the ear, but not to the eye. Very few get it right in any grade. It was rejected. "Tomato" is curious. On the whole neither school does any better with it in the highest than in the lowest grades. It was not taken. This word and the word "handful" strongly suggest the need of a greater number of pupils to test. The word "too" is a word which is misspelled with astonishing frequency. The difficulty is not so much one of spelling as of confusion with the other two words which have the same pronunciation. It was not used in the Selected List but was later included in a small supplementary list just to "try it out." "Whose" was taken although it shows a dip in the 5th and 6th grades. Pupils in these grades have learned the use of the apostrophe and their "little knowledge" proves a "dangerous thing" which the pupils of the earlier grades avoid.

These words—each more or less typical in its way—show how from the Original List of 270 a better Selected List of 100 was chosen. Again the words were put into sentences, as follows:

*Whose answer is ninety? If the janitor sweeps, he will raise a dust. You ought not to steal even a penny. Wait until the hour for recess to touch the button. Smoke was coming out of their chimney. Every afternoon the butcher gave the hungry dog a piece of meat. One evening a carriage was stopping in front of my kitchen. I wear a number thirteen collar. Guess what made me sneeze. Send me a pair of leather shoes. I do not know, but I am almost sure they are mine. My uncle bought my cousin a pretty watch for forty dollars. The soldier dropped his sword. Jack had a whistle and also twelve nails. The ocean does not often freeze. You should speak to people whom you meet. It takes only a minute to pass through the gate and across the road. Did you ever hear a fairy laugh? The American Indian had a saucer without a cup. Neither a pear nor a peach was at the grocery store to-day. Cut up a whole onion with a handful of beans. My piano lesson was easy. The animal ran into the road and straight against a tree. Give me another sentence which has the word "title" in it. I believe true friends like to be together instead of apart.*

These sentences were dictated at schools III, IV, and V in the spring term of 1911. They were later (fall of 1912) dictated at schools VI and VII.

The following instructions were given to the examiners:

Please read these instructions through before beginning to dictate the sentences.

I. See that *each sheet* is headed with (a) the pupil's name, (b) the date, (c) the grade, (d) the name of the school.

II. Give all the sentences during one session, i.e., either in the morning or the afternoon of the same day.

III. In classes below the fifth year dictate in two periods, separated by at least half an hour, or by a recess period.

IV. Each sentence may be dictated, either in whole or in part, as many times as may seem necessary to secure its complete understanding. This exercise is purely a test in spelling. It is not intended that pupils should be subjected to the added difficulty of an effort to recall the words dictated.

V. Offer no explanation of words or sentences. If the meaning is not clear, repeat the sentence as a whole or in part.

VI. Do not ask the children to underline words nor otherwise call their attention to the significant words of the sentences.

VII. After the children have written the sentences, read them again and allow pupils to insert words or make other corrections.

VIII. Collect the papers.

Subsequently at the same schools (III, IV, and V) was given a supplementary list of 18 words, again selected from the Original List (270 words). With the same directions to the examiners, these words were put into sentences as follows:

*Telephone me on Tuesday if the tobacco comes. The tailor sent a saucy telegram. Already the circus was beginning. Pigeons seem too beautiful to quarrel. I am trying to choose a towel. The chicken was fried in grease.*

Each of these 118 words was scored in each grade and for each school separately. Table II illustrates for a few of the words the manner in which this was done. The figures indicate per cent correct. 3a means third grade, first half; 3b third grade, second half, etc. III, IV, and V refer to different schools.

It will be seen at once that there is no steady progression for each word as we pass from the lowest to the highest grades. In fact for this and for other reasons it was found best to deal with grades by years rather than by half-years. It also seemed advisable to choose a few of these words and to make them the basis of study.

### § 5. *The Preferred Lists*

From the data now in hand it was possible to select a few words which showed reasonably regular increase from grade to grade in the per cent of times they were spelled correctly. Two lists were made up, each containing twenty-five words. The first list is superior to the second in the testing power of the words in all grades and in the permanence of their relative difficulty throughout the grades. That is, to a somewhat greater extent than in the case of the second list, the words of the first list are found to be easy enough for low grades and hard enough for high grades. Also, a word occupying a certain serial position (say the 4th in point of difficulty for the third grade) tends more strongly in the first than in the second list to occupy the same position in all other grades. That both lists, however, are reasonably satisfactory in these particulars will be abundantly shown.

TABLE II  
FIGURES INDICATE PER CENT CORRECT

GRADE . . . . .	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b
against												
III . . . . .	20	60	54	43	60	62	60	91	73	93	97	95
IV . . . . .	5	19	26	29	70	61	92	78	95	94	100	97
V . . . . .	0	0	10	15	30	52	54	74	63	81	88	89
believe												
III . . . . .	8	77	37	54	53	44	35	57	73	93	73	85
IV . . . . .	0	3	17	36	32	22	50	52	62	78	83	78
V . . . . .	0	4	24	14	28	55	76	50	77	71	84	72
cousin												
III . . . . .	12	16	44	72	78	83	91	95	98	97	100	100
IV . . . . .	10	39	38	58	72	82	97	93	97	96	100	100
V . . . . .	11	28	45	38	55	68	84	74	68	90	86	91
know												
III . . . . .	22	40	63	75	73	70	88	82	93	97	97	100
IV . . . . .	37	61	68	71	78	81	85	93	97	98	98	100
V . . . . .	33	38	62	60	60	84	80	79	79	88	100	96
ninety												
III . . . . .	56	61	65	46	60	65	70	86	71	80	97	80
IV . . . . .	15	25	54	19	59	49	61	60	87	82	83	86
V . . . . .	0	11	28	14	36	52	64	61	62	71	79	74
pigeons												
III . . . . .	0	2	13	31	24	61	66	49	83	64	96	86
IV . . . . .	8	6	74	50	63	22	57	67	81	74	84	95
V . . . . .	0	45	9	32	61	50	82	64	50	89	80	84
saucer												
III . . . . .	7	4	17	52	45	40	33	73	78	83	80	75
IV . . . . .	10	10	16	36	49	51	73	60	83	72	78	78
V . . . . .	0	16	31	19	21	52	66	45	66	79	81	78
too												
III . . . . .	0	0	15	58	64	46	14	60	24	14	65	32
IV . . . . .	3	45	34	27	54	40	10	11	33	33	53	45
V . . . . .	0	45	0	85	18	26	36	41	18	26	51	39

The first list will be called the "First Preferred List." It contains the following words:

1. even	10. forty	18. saucer
2. lesson	11. pretty	19. stopping
3. only	12. wear	20. sword
4. smoke	13. button	21. freeze
5. front	14. minute	22. touch
6. sure	15. cousin	23. whistle
7. pear	16. nails	24. carriage
8. bought	17. janitor	25. nor
9. another		

The second list, called the "Second Preferred List," is as follows:

1. already	10. tailor	18. whole
2. beginning	11. telegram	19. against
3. chicken	12. telephone	20. answer
4. choose	13. tobacco	21. butcher
5. circus	14. too	22. guess
6. grease	15. towel	23. instead
7. pigeons	16. Tuesday	24. raise
8. quarrel	17. tying	25. beautiful
9. saucy		

Table III gives for each word of the First Preferred List and for each grade the number of times the word was written, the number of times it was spelled correctly, and the per cent correct. Schools I, II, III, IV, and V are included. (Omitted words are considered as "written" and as wrong.) Table IV gives the same facts for the Second Preferred List.

It will be seen from tables III and IV that for any given word the per cent correct in one grade is higher than it is in any lower grade. This is, of course, to be expected. But it is not sufficient. In order that this list should be of greatest value it should be so constituted that these increases in 'percents-correct' so keep pace with the increase from grade to grade of general spelling ability that a word tends in all grades to maintain the same difficulty relative to all other words in the list to which it belongs. A word which is 20th in point of difficulty for the 3d grade ought to deviate as little as possible from the same rank in the other grades. The experience gained in making this investigation leads us to think that most words do not meet this condition even approximately. The span between the 3d and the 8th grades is very wide. Accordingly a very large class of words is impossible for the earlier, yet easy for the later, grades. Still others are really difficult in the lower grades but of almost no difficulty in the upper grades. From our own Original List "coffee" and "people" are hard for 3d- and 4th-graders, but are almost always spelled correctly above the 6th grade. A third group of words breaks down in the middle. They appear to be easy in the lowest and highest

TABLE III  
FIRST PREFERRED LIST

GRADE	3D YEAR			4TH YEAR			5TH YEAR			6TH YEAR			7TH YEAR			8TH YEAR					
	No. tak- ing cor- part rect																				
even.....	426	59	3	485	384	79	1.5	537	476	89	1.5	459	428	93	3	395	368	93	7		
lesson.....	421	154	37	425	37	12	478	345	72	3.5	531	440	83	4	456	416	91	4.5			
only.....	423	275	65	485	365	75	2	535	476	89	1.5	450	434	95	1	397	385	97	1.5		
smoke.....	426	197	46	7	485	336	69	5	537	459	85	3	459	432	94	2	395	380	96	2	
front.....	424	215	51	4	485	348	72	3	538	431	80	5	458	414	90	6.5	388	365	94	4.5	
sure.....	425	200	47	6	487	267	55	11.5	538	372	69	10.5	458	365	78	14.5	388	345	89	10.5	
pear.....	421	129	31	16	486	206	42	20.5	536	309	58	19.5	453	327	72	19.5	397	321	81	19	
bought.....	425	169	40	11	489	320	65	7	536	422	79	6	453	414	91	4.5	396	374	94	4.5	
another.....	421	151	36	13	483	206	43	19	535	419	78	7	459	393	86	10	397	372	94	4.5	
forty.....	425	209	49	5	489	301	62	8	536	346	65	13.5	453	324	72	19.5	396	328	83	17	
pretty.....	425	190	45	5	464	313	67	6	539	411	76	8	460	414	90	6.5	397	358	90	9	
wear.....	424	149	35	14	483	236	49	15	531	322	61	16.5	456	336	74	17	396	331	84	15.5	
button.....	426	135	32	15	461	238	52	13.5	537	328	61	16.5	459	336	73	18	394	293	74	25	
minute.....	423	109	26	19	484	185	38	24	538	331	62	15	458	351	77	16	388	334	86	13	
cousin.....	425	81	19	21.5	488	227	47	16	537	370	69	10.5	459	409	89	8	395	355	89	10.5	
nails.....	425	184	43	10	464	268	58	10	539	385	71	9	460	398	87	9	398	365	92	8	
janitor.....	426	82	19	21.5	485	202	42	20.5	537	309	58	19.5	459	373	81	12.5	395	319	81	19	
saucer.....	422	48	11	25	485	141	29	25	535	225	42	25	459	268	58	25	397	312	79	21	
stopping.....	424	113	27	18	485	101	39	23	538	294	55	23	458	326	71	21	388	296	76	23	
sword.....	425	56	13	23	5	464	213	46	17.5	539	308	57	21	460	361	78	14.5	398	343	86	13
freeze.....	425	185	29	17	464	262	46	17.5	537	363	68	12	459	379	83	11	395	340	86	13	
touch.....	426	191	45	8	5	461	242	52	13.5	537	324	60	18	459	370	81	12.5	394	331	84	15.5
whistle.....	425	91	22	20	464	254	55	11.5	539	304	56	22	460	294	64	24	398	299	75	24	
carriage.....	424	55	13	23	5	485	194	40	22	538	271	50	24	458	308	67	23	388	313	81	19
nor.....	421	267	63	2	461	281	61	9	538	348	65	13.5	460	311	68	22	398	307	77	22	

TABLE IV  
SECOND PREFERRED LIST

GRADE	3D YEAR				4TH YEAR				5TH YEAR				6TH YEAR				7TH YEAR				8TH YEAR					
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	
already.....	60	16	15	486	205	42	12	437	186	43	19	364	225	62	19	352	154	44	23	257	199	77	22	257	192	
beginning.....	371	33	9	23	486	119	25	24	437	162	37	23	364	166	46	23	352	231	66	21	257	192	75	23	257	192
chicken.....	371	183	49	1	487	341	70	1.5	436	362	83	1	365	329	90	1	352	338	96	1	257	256	99	1	257	256
choose.....	371	83	22	9	463	157	34	18	436	219	48	17	365	219	60	20	348	227	65	22	257	210	82	19.5	257	210
crews.....	371	75	20	1.5	463	180	39	14	438	215	50	15	366	214	72	14	351	262	75	17	257	245	95	6	257	245
grease.....	371	39	11	21	463	82	18	25	436	136	37	23	365	128	35	24	348	146	42	24	257	146	57	24	257	146
pigeons.....	371	24	7	25	463	134	29	22	436	177	41	20	365	208	57	21	348	244	70	20	257	210	82	19.5	257	210
quarrel.....	371	54	15	16	484	191	39	14	430	229	53	14	362	272	75	10	350	300	86	9	257	241	94	8.5	257	241
saucy.....	371	53	14	18.5	463	161	35	16	438	174	40	21	366	191	52	22	351	248	71	19	257	200	78	21	257	200
tailor.....	371	141	38	4	486	267	55	5	437	306	70	3	364	273	75	10	342	277	81	13	257	217	84	17.5	257	217
telegram.....	371	57	15	16	484	149	51	20	430	168	39	22	362	228	63	18	350	254	73	18	257	216	84	17.5	257	216
telephone.....	371	30	8	24	484	167	35	16	430	207	48	17	362	244	67	16	350	289	83	12	257	223	87	14.5	257	223
tobacco.....	371	43	12	20	463	179	39	14	436	262	60	12	365	274	75	10	348	305	88	6	257	248	96	4.5	257	248
towel.....	371	52	14	18	487	134	28	23	436	117	25	25	365	86	24	13	349	104	30	25	257	111	43	25	257	111
Tuesday.....	371	88	24	8	463	206	44	10	436	280	64	9.5	365	267	73	13	348	271	78	14	257	241	94	8.5	257	241
tying.....	371	169	46	2	487	340	70	1.5	436	291	67	7	365	292	80	7	349	303	87	7.5	257	233	91	11.5	257	233
whole.....	371	162	44	3	487	282	58	4	436	305	70	3	362	246	68	15	350	266	76	16	257	224	87	14.5	257	224
against.....	421	71	17	14	457	207	43	11	537	346	64	9.5	460	558	78	8	395	333	84	10.5	267	248	96	4.5	267	248
answer.....	421	80	19	13	480	146	30	21	538	291	54	13	458	345	75	10	395	332	84	10.5	267	251	94	8.5	267	251
butcher.....	424	116	27	7	486	228	47	9	536	360	67	7	453	389	86	2.5	395	360	90	4.5	267	259	97	2.5	267	259
guess.....	425	83	20	11.5	462	147	32	19	537	262	49	16	459	309	67	16.5	393	302	77	15	267	228	85	16	267	228
instead.....	421	134	32	6	484	231	48	8	535	332	62	11	459	393	84	2.5	396	346	87	7.5	267	242	91	11.5	267	242
raise.....	426	21	10	22	485	261	54	7	535	356	67	7	459	387	84	6	396	369	93	3	267	252	94	8.5	267	252
beautiful.....	371	36	10	22	493	256	52	7	436	307	70	3	365	311	85	4.5	349	327	94	2	257	248	96	4.5	257	248

and hardest in the middle grades. "Whose" is a type of such a word. It presents no great difficulty until children learn the use of the apostrophe. Then they write "who's." Later they partly recover from this practice. There are quantities of words which show this dip in the middle grades. One homonym is often easy until the other has been consciously related to it. Analogies falsely assumed play a harmful rôle. The rapid enriching of the vocabulary as new subjects and new phases of old subjects are taken up in the middle grades probably induces some confusion. To just what extent this is true we do not know but we are sure that it is true to a significant degree.

Finally, we have the large class of words which—when a sufficient number of children are tested—do show an increase in correctness from grade to grade, but which do not advance in anything like a constant ratio to the advance from grade to grade in spelling ability. Even among the words chosen as most favorable this discrepancy may be seen. The word "sure" (Table III) is 47 per cent correct in the 3d grade. This gives it a rank of 6th among the 25 words of the First Preferred List for that grade. In the 4th grade it advances to 55 per cent correct, but this advance is not sufficient to maintain its position. It falls to a rank where it is tied with "whistle" for 11th and 12th place—i.e., its rank is 11.5. In the 5th, 6th, 7th, and 8th grades its rank remains fairly constant with the 4th-grade rank. It is 10.5, 14.5, 10.5, and 12.

If this sort of irregularity is found in a word chosen as among the most regular, it will easily be seen how much greater would be the irregularity of words which were rejected.

#### § 6. *Examination of the First Preferred List*

To further establish the value of the lists, we may investigate the behavior of the words as between grades in each school and in all schools combined. We shall begin with the First Preferred List. This list was chosen in the first instance from the returns of School I. It was taken to be the 25 words of closest correlation between the grades of that school. It was then referred to the other schools and the correlations were worked out for them.

The method used was that suggested by Spearman in his article: “‘Foot-rule’ for Measuring Correlation” (Spearman, '06). This method is explained and criticised by Brown in “The Essentials of Mental Measurement,” pp. 71-76 (Brown, '11), and in a more elementary way by Whipple in his “Manual,” pp. 34 and 35. (Whipple, '10.)

The formula is

$$R = 1 - \frac{\Sigma(g)}{1/6(N^2 - 1)}$$

where  $\Sigma(g)$  denotes the sum of the “gains” in rank (sum of positive differences) of the second series on the first, and  $1/6(N^2 - 1)$  is the value of the sum of such gains which may be expected by chance. These  $R$ -values were then expressed as  $r$ -values (Pearson Coefficients of Correlation) by means of a table of equivalents. This table (Whipple, '10, p. 36), has been

worked out from Spearman's conversion formula  $r = \sin \left( \frac{\pi}{2} R \right)$ .

The method is illustrated for the 4th and 5th grades of School I in Table V.

By the formula,  $R = 1 - \frac{\Sigma(g)}{1/6(N^2 - 1)}$ ,  $R = .72$ . This is

equivalent to an  $r$ -value of .90. The correlation is therefore very satisfactory. Its Probable Error is .026, which is so small in relation to the obtained correlation, that the latter has a very high degree of reliability.

The correlation of each grade with every other grade for School I was as follows:

Correlation of 4th grade with 5th grade,	.90
“ “ 4th “ “ 6th “ .88	
“ “ 4th “ “ 7th “ .88	
“ “ 5th “ “ 6th “ .92	
“ “ 5th “ “ 7th “ .93	
“ “ 6th “ “ 7th “ .88	
Average.....	.90
(P. E. = .026)	

TABLE V  
SCHOOL I. COEFFICIENTS OF CORRELATION FOR 4TH AND 5TH  
GRADES DERIVED. FOOT-RULE METHOD

	4th Grade		5th Grade		Gains, 5th on 4th
	%	Rank	%	Rank	
even . . . . .	90	1	94	2	1
lesson . . . . .	80	2	85	4.5	2.5
only . . . . .	77	3.5	96	1	..
smoke . . . . .	77	3.5	81	7	3.5
front . . . . .	70	5.5	75	11	5.5
sure . . . . .	70	5.5	85	4.5	..
pear . . . . .	69	7	77	10	3
bought . . . . .	67	8	83	6	..
another . . . . .	65	9	79	8.5	..
forty . . . . .	63	10.5	72	13	2.5
pretty . . . . .	63	10.5	89	3	..
wear . . . . .	56	12	73	12	..
button . . . . .	50	13	70	14	1
minute . . . . .	49	14	65	16	2
cousin . . . . .	42	15.5	65	16	.5
nails . . . . .	42	15.5	79	8.5	..
janitor . . . . .	40	17.5	56	19	1.5
saucer . . . . .	40	17.5	65	16	..
stopping . . . . .	30	19	47	23	4
sword . . . . .	25	20	50	22	2
freeze . . . . .	21	22	63	18	..
touch . . . . .	21	22	52	21	..
whistle . . . . .	21	22	55	20	..
carriage . . . . .	17	24	45	24	..
nor . . . . .	13	25	43	25	..
					29 = $\Sigma (g)$

It may be interesting before taking up the results in other schools to see to what extent the 'foot-rule' method justifies itself in this kind of work. The 'product-moment' ( $r = \frac{\Sigma xy}{n\sigma_1\sigma_2}$ ) and the 'unlike signs' methods ( $r = \cos \pi v$ ) were used as a check. Table VI shows the result.

It is evident from Table VI that if the true numerical statement of the amount of correlation may be expected to be at or near the average of all three methods, the one which tends most nearly to approximate the true result is here the 'foot-rule'

TABLE VI

r-VALUES BETWEEN GRADES OF SCHOOL I AS FOUND BY THREE METHODS

Pairs of Grades	Foot-rule	Product-moment	Unlike signs	Average
4th with 5th.....	.90	.92	.99	.94
4th " 6th.....	.88	.76	.97	.87
4th " 7th.....	.88	.73	.81	.81
5th " 6th.....	.92	.78	.99	.90
5th " 7th.....	.93	.79	.88	.87
6th " 7th.....	.88	.91	.93	.91
Averages.....	.90	.82	.93	.88

method. It has therefore seemed justifiable in future computations of this sort to save the threefold labor and to rely upon this method.

It is to be expected that since the list of words was in the main selected from the results in School I, the correlation will prove to be higher in that school than in any other. Such is indeed the case as will be seen by an inspection of Table VII. It will be remembered that School I has no 8th grade and that the 3d grade in that school was not tested.

We find that the correlations in School II are considerably lower than in schools III, IV, and V, even showing an apparent inverse relation in one instance. Yet the average of the coefficients for School II is .42, the P.E. of which is less than .11. A correlation is entitled to scientific consideration if it is more than twice as large as its probable error. This one is nearly four times its probable error, and may therefore be regarded as satisfactory. Still more so are the relations between grades in the other schools; while, for all schools combined, the coefficients of grade-to-grade correlation range from .47 to .93 with an average of .76, A.D=.12. Since for these same values P.E. ranges from .10 to .02 with an average at .057, the reliability of these values is adequate.

It appears therefore that this list of words possesses the advantage of maintaining practically the same order of difficulty throughout the grades from the 3d to the 8th. In any grade the hardest word, the easiest word, and the words which take rank between tend strongly to hold their positions in every

other grade. Our list then is to a marked degree independent of fluctuations between grades.

But this might be true and still leave something to be desired. Schools differ in many respects—in quality of teaching and supervision, in preferred methods, in word lists studied, in the character of the children as to economic and racial condition. The schools which we have under consideration differ widely in all those respects. These variations in local conditions may very likely produce considerable variation in the quality of the spelling output.

TABLE VII  
COEFFICIENTS OF CORRELATION. GRADE WITH GRADE, AND EACH  
GRADE WITH ALL GRADES FOR EACH SCHOOL. FIRST  
PREFERRED LIST

School . . . . .	II	III	IV	V	All schools
3d with 4th. . . . .	.37	.78	.67	.69	.79
" " 5th. . . . .	.25	.55	.31	.71	.71
" " 6th. . . . .	—.07	.40	.45	.75	.55
" " 7th. . . . .	.40	.23	.34	.75	.47
" " 8th. . . . .	.01	.31	.47	.67	.71
" " entire school. . . . .	.35	.79	.77	.85	.82*
4th " 5th. . . . .	.81	.59	.61	.89	.83
" " 6th. . . . .	.54	.59	.62	.84	.69
" " 7th. . . . .	.37	.37	.60	.73	.62
" " 8th. . . . .	.20	.34	.62	.77	.72
" " entire school. . . . .	.78	.84	.84	.92	.90*
5th " 6th. . . . .	.72	.60	.90	.93	.90
" " 7th. . . . .	.60	.69	.88	.90	.86
" " 8th. . . . .	.52	.48	.83	.72	.93
" " entire school. . . . .	.91	.84	.82	.95	.98*
6th " 7th. . . . .	.56	.66	.94	.89	.90
" " 8th. . . . .	.62	.60	.85	.89	.89
" " entire school. . . . .	.77	.77	.84	.93	.88*
7th " 8th. . . . .	.45	.76	.90	.80	.89
" " entire school. . . . .	.75	.61	.78	.89	.86*
8th " entire school. . . . .	.60	.57	.82	.81	.91*
Average, grade with grade. . . . .	.42	.53	.67	.80	.76
Average, grade with school . . . . .	.69	.74	.81	.89	.89*

\* These  $r$ -values are for each grade with the grades of all schools

TABLE VIII

CORRELATIONS OF SCHOOL WITH SCHOOL AND OF EACH SCHOOL WITH  
ALL SCHOOLS FOR EACH GRADE. FIRST PREFERRED LIST

School I is not included because of its different system of grading

Grades.....	3d grade	4th grade	5th grade	6th grade	7th grade	8th grade	All grades
School II with III.....	.45	.60	.82	.55	.51	.31	.70
"    II "    IV.....	.32	.74	.66	.78	.56	.56	.80
"    II "    V.....	.61	.82	.87	.60	.59	.29	.88
"    II "    All.....	.62	.76	.93	.87	.88	.61	.91*
"    III "    IV.....	.76	.66	.60	.73	.62	.60	.88
"    III "    V.....	.54	.77	.79	.78	.47	.50	.81
"    III "    All.....	.88	.89	.87	.73	.77	.61	.87*
"    IV "    V.....	.77	.75	.78	.67	.60	.64	.85
"    IV "    All.....	.83	.84	.82	.93	.83	.83	.93*
"    V "    All.....	.83	.86	.95	.78	.79	.85	.93*
Average, school with school....	.58	.72	.75	.69	.56	.48	.82
Average, each school with all schools.....	.79	.84	.89	.83	.82	.73	.91*

\* These figures are for each school with all grades and schools combined, i.e., with all participants.

A method in reading and word study which makes extensive use of the phonogram may possibly cause some words to become easy which are otherwise difficult. If the pupils in one school come from homes where English is not spoken, they may find difficult a set of words other than that which children of English-speaking parents find difficult.

With the purpose of throwing some light on this point we shall consider what the correlation is *between schools* for each grade and for all grades with respect to the First Preferred List. Table VIII shows the correlation coefficients. The school-with-school average correlations range from .48 to .82 with a median at .69. The school-with-all-school averages range from .73 to .91 with a median at .83. A few of the coefficients throughout the table are low. There are, however, but six that are below .50. All but one of these are in the extreme grades (3d or 8th) and have to do with School II. The circumstances under which this school was examined account for this. The tests were given

immediately after the long summer vacation and the test-material comprised the Original List (270 words). The other schools were tested considerably later in the school year and the pupils in those schools wrote the Selected List (100 words).

Notwithstanding these few shortcomings the 70 coefficients of Table VIII form an impressive argument for the value of the First Preferred List. We may fairly contend that not only are the positions of the words of this list relatively stable as between grades (Table VII), but that this permanency holds as between schools.

### § 7. *Examination of the Second Preferred List*

The second list of 25 words (see p. 13 or Appendix II) was examined in the same way that the first list was examined, i.e., with reference to correlations first between grades, and second between schools.

At School I the correlations between grades were found to be as follows (Compare with similar tabulation for the First Preferred List on page 17):

4th	grade	with	5th	grade	.87
4th	"	"	6th	"	.83
4th	"	"	7th	"	.79
5th	"	"	6th	"	.95
5th	"	"	7th	"	.78
6th	"	"	7th	"	.83
Average....				.84	
(P.E.=.04)					

For the other schools Table IX shows the correlations. It may be compared with Table VII (page 20).

A comparison of Table IX with Table VII shows that although the word list to which Table IX refers was taken, on the basis of partial knowledge, to be somewhat inferior to the First Preferred List, these coefficients do not show it. The grade-with-grade averages (.66, .67, .60, .48, and .75) are higher for some schools than in Table VII and lower for others. Their central tendency is almost identical while the closeness of grouping is greater for the second than for the first list. Of the

105 measures of correlation in Table IX only 13 are less than four times their probable error, and only 3 are less than twice their probable error. The grade-to-grade relationships for all schools (column 6) range from .40 to .95, average .75, A.D. = .14. This is satisfactory to a degree scarcely, if at all, less than is the showing for the first list.

TABLE IX  
COEFFICIENTS OF CORRELATION. GRADE WITH GRADE AND EACH  
GRADE WITH ALL GRADES FOR EACH SCHOOL. SECOND  
PREFERRED LIST

School	II	III	IV	V	All schools
3d with 4th.....	.60	.75	.55	.38	.74
" " 5th.....	.69	.62	.56	.26	.73
" " 6th.....	.61	.55	.55	.11	.55
" " 7th.....	.43	.55	.41	.07	.40
" " 8th.....	.51	.52	.35	—.01	.41
" " entire school.....	.73	.84	.75	.34	.72*
4th " 5th.....	.73	.82	.69	.48	.90
" " 6th.....	.74	.61	.44	.40	.80
" " 7th.....	.60	.62	.45	.38	.69
" " 8th.....	.57	.60	.51	.38	.62
" " entire school.....	.82	.88	.78	.67	.93*
5th " 6th.....	.75	.76	.74	.84	.90
" " 7th.....	.55	.75	.73	.65	.83
" " 8th.....	.62	.73	.72	.83	.80
" " entire school.....	.81	.92	.90	.92	.95*
6th " 7th.....	.83	.67	.79	.76	.94
" " 8th.....	.82	.71	.77	.84	.89
" " entire school.....	.93	.82	.84	.88	.91*
7th " 8th.....	.80	.80	.74	.86	.90
" " entire school.....	.88	.83	.80	.78	.87*
8th " entire school.....	.89	.80	.81	.86	.80*
Average, grade with grade....	.66	.67	.60	.48	.75
Average, grade with school...	.84	.87	.81	.74	.86*

\* These  $r$ -values are for each grade with all grades of all schools.

Table X (whose counterpart for the first list is Table VIII) reveals, as Table IX did not, the relative inferiority of the second list. There are 49 coefficients in Table X that are lower than the corresponding figures in Table VIII. Only 21 are

higher. The school-with-school averages are lower in five instances and higher in but two. The order of difficulty of these words is therefore not so permanent as between schools. It is, however, sufficient abundantly to justify the list. There are but six of the 70 coefficients in the body of the table that are less than four times their probable error, and but three that are less than twice their probable error. In some respects, indeed, this list is superior to the first list. A comparison of

TABLE X

CORRELATIONS OF SCHOOL WITH SCHOOL AND OF EACH SCHOOL WITH  
ALL SCHOOLS FOR EACH GRADE. SECOND PREFERRED LIST  
School I not included. Compare with Table VIII, p. 21

		3d grade	4th grade	5th grade	6th grade	7th grade	8th grade	All grades
School	II with III.....	.48	.51	.47	.65	.60	.52	.66
"	II " IV.....	.29	.17	.52	.65	.45	.38	.43
"	II " V.....	.05	-.08	.52	.55	.43	.64	.60
"	II " All.....	.57	.56	.84	.95	.76	.83	.84*
"	III " IV.....	.55	.38	.82	.60	.61	.67	.59
"	III " V.....	.47	.43	.62	.59	.72	.84	.87
"	III " All.....	.76	.78	.78	.80	.85	.84	.88*
"	IV " V.....	.47	.43	.55	.59	.81	.66	.65
"	IV " All.....	.79	.76	.74	.75	.65	.69	.77*
"	V " All.....	.62	.57	.82	.65	.84	.88	.78*
Average, school with school.....		.39	.31	.58	.61	.60	.62	.63
Average, each school with all schools.....		.69	.68	.80	.79	.78	.81	.82*

\* These figures are for each school with all grades and schools combined, i.e., with all participants.

Tables III and IV shows that the words of the second list are in general more difficult than those of the first. Doubtless the first list is a somewhat better test for lower grades, while the second is a better test for upper grades. This supposition is neatly supported by the figures in Table X. Sixteen of the 21 that are higher in this table than in Table VIII are in the three upper grades, while the two higher *average* correlations are in the 7th and 8th grades. If, therefore, some of the words in the first list are found to be too easy for the highest grades—as

doubtless they may be—then the second list will supply a valuable supplement to the first.

### § 8. *Conclusions Regarding the Preferred Lists*

Our lists therefore prove to be well selected. Success and failure in spelling them may be used with considerable confidence to measure the thing we call spelling ability. The establishment of this fact is of the utmost importance. In general when we are to measure mental traits or capacities the thing we directly measure is itself a physical phenomenon or fact. We measure fatigue by the number and height of lifts with the ergograph, or by the distance between points of the esthesiometer necessary to be recognized as 'two.' We measure attention and perception by counting dots or by cancellation; memory, by the number of digits reproduced; association by the number of words pronounced in a given time; and intelligence itself, by a series of tests which may be scored objectively. What we deal with directly is something, assumed to be functionally related to the trait in question, which can be measured in time or space or which can be counted. If this objective manifestation does not accurately register the subjective state to which it is supposed to correspond, it is impaired, to the extent of its inaccuracy, as an index to be directly measured.

Now it is undoubtedly true that the misspellings of most words are unreliable as indicating lack of spelling ability in general; and on the other hand it is probable that to spell them correctly often argues little more than that the subject can spell the particular words that he did spell. Most words are in some way special—and they are special (particularly for children) in ways that we do not realize. Very often they do not mean the same thing to one person that they do to another. They are frequently pronounced differently by different people. They suggest dissimilar imagery. They connote variously. They range from very easy to very hard; and those that are easy for some people are hard for others. Moreover there are numerous ways of misspelling them, each indicating its own causal incoördination. An error may not be equal to an error even in misspelling the same word.

It would be presumptuous to suppose that all these difficulties have been overcome in selecting our two preferred lists. Without doubt we have only roughly approximated the ideal conditions under which a physical fact may be the transcript of a mental trait. Probably nothing more satisfactory than an approximation can be devised. But we have been at no small pains to secure a list of words which would be free from many of these variations, and we think we have done so. From an inspection of them we may be justified in believing that their pronunciation and meaning are fairly constant for everybody; and we may regard it as probable that their associative connections do not vary much for different people. From a statistical analysis of them we find that their behavior with elementary school children is constant to a marked degree, and in particular that it is relatively independent of maturity and of local conditions. Older children in higher grades spell them more frequently and in each grade more frequently than in the one before it. Children in schools under favorable circumstances do better with them than do children in less favorable situations. It is because they reflect these conditions that they are valuable. By the use of them, conditions in a school, a class, or an individual may be revealed; and conversely to a certain extent if the conditions are known (e.g., the grade) the results, by the use of them, are predictable.

These lists, then, tend strongly to remain intact under various conditions. As lists they appear to be reliable, and our numerical results give quantitative expression to this reliability. But as to the words themselves, we shall yet have much to say. There has been no attempt to secure lists composed of words of equal difficulty. The effort has rather been to choose words which differ widely in this respect. We shall now attempt to arrange these words on a scale which shall accurately represent their difficulty, assuming as true a certain supposition concerning the form of distribution of spelling ability within a school grade. The resulting scale will represent their difficulty approximately in so far as this supposition is approximately true. When this is done, their value for test purposes independently of the list which contains them will be established.

## § 9. Ratings of Individual Pupils

In addition to scoring words, the papers of individual pupils were rated. This was done in the usual manner, the ability to spell one word being scored as equal to the ability to spell any other word of the list. This procedure is subject to the criticism made in Section I above; but in the absence of any evaluation of the words, a system of weighting is not possible. The results will not be misused here.

The test material consisted of the 100 words of the Selected List. The papers written at schools II, III, IV, and V were used. School I was not available because of its system of grading. A few papers were incomplete in each of the schools; these were rejected in this part of the work. In all, 2,487 papers were rated. Table XI shows for each grade the distribution of in-

TABLE XI  
DISTRIBUTION OF INDIVIDUAL RATINGS OF PUPILS IN  
SCHOOLS II, III, IV AND V

Percentage Correct	3d Grade		4th Grade		5th Grade		6th Grade		7th Grade		8th Grade	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0- 5	9	2.0	1	.2	1	.2						
6- 10	22	4.9	1	.2	2	.4						
11- 15	30	6.7	10	2.1	1	.2						
16- 20	38	8.5	12	2.6	2	.4						
21- 25	44	9.9	13	2.8	6	1.2	2	.5				
26- 30	47	10.6	23	4.9	12	2.3						
31- 35	34	7.6	29	6.2	13	2.5	2	.5	2	.5		
36- 40	38	8.5	27	5.8	11	2.1						
41- 45	24	5.4	30	6.4	18	3.5	6	1.4	2	.5		
46- 50	34	7.6	33	7.1	28	5.4	4	1.0	1	.3		
51- 55	26	5.8	27	5.8	20	3.9	6	1.4	3	.8		
56- 60	24	5.4	31	6.6	32	6.2	15	3.6	5	1.4	1	.4
61- 65	26	5.8	39	8.4	44	8.5	12	2.9	6	1.6	1	.4
66- 70	17	3.8	29	6.2	48	9.3	23	5.5	8	2.2	3	1.1
71- 75	13	2.9	45	9.6	49	9.5	30	7.2	18	4.9	8	2.9
76- 80	8	1.8	35	7.5	59	11.5	52	12.4	31	8.5	11	4.0
81- 85	4	.9	33	7.1	37	7.2	67	16.0	38	10.4	19	6.9
86- 90	4	.9	26	5.6	64	12.4	61	14.6	79	21.6	41	14.8
91- 95	3	.7	19	4.1	50	9.7	101	24.2	93	25.5	80	28.9
96-100			4	.9	18	3.5	37	8.9	79	21.6	113	40.8
Totals...	445		467		515		418		365		277	
Medians...		35.8		60.70		73.10		84.90		90.50		94.68
A. D....		18.0		20.9		10.4		10.0		7.9		5.8

dividual ratings. It reads as follows: "In the 3d grade 9 pupils were rated between 0% and 5%, which was 2.0% of all the 3d grade pupils. In the 4th grade 1 pupil was rated between 0% and 5%, which was .2% of all the 4th grade pupils," etc.

The striking characteristic of the distribution of these ratings is their extreme variability. Children of the 3d grade are represented in every group but one, while children of the 4th and 5th grades are rated in every group. It appears that we may expect a few 6th- and 7th-grade children to spell not more than 20 or 30 of these hundred words, which is not quite as good as the typical ability of 3d-grade children for the same words. The 8th-grade pupils show the least variation. This is probably true of this grade in general. It is not, however, as marked as these figures indicate. The 100-word list as a whole, whatever may be true about some of the individual words, did not thoroughly test this grade. A glance at Fig. 6 will show how sharply cut off at the high end is the curve of distribution. This is against all the facts which we know about eighth-graders in particular and human ability in general. A harder test would have shown a lower mode and a more gradual tapering off at the upper end of the curve. But even as this record stands we may look for a considerable number—between 7 and 8 per cent—of 8th-grade pupils to average no better than the typical performance of 5th-grade children.

TABLE XII

DISTRIBUTION OF INDIVIDUAL RATINGS GROUPED TO SHOW MODES. FIGS. 1-7

Percentage Correct	3d Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade
0- 10.....	6.9	.4	.6			
	22.1	5.1	1.2			
11- 20.....	15.2	4.7	.6			
21- 30.....	20.5	7.7	3.5	.5	1.0	
	36.6	19.7	8.1			
31- 40.....	16.1	12.0	4.6	.5	.5	.5
41- 50.....	13.0	13.5	8.9	2.4	.8	
	24.2	25.9	19.0	7.4	3.0	
51- 60.....	11.2	12.4	10.1	5.0	2.2	.4
61- 70.....	9.6	14.6	17.8	8.4	3.8	1.5
	14.3	31.7	38.8	28.0	17.2	8.4
71- 80.....	4.7	17.1	21.0	19.6	13.4	6.9
81- 90.....	1.8	12.7	19.6	30.6	32.0	21.7
	2.5	17.7	32.8	63.7	79.1	91.4
91-100.....	.7	5.0	13.2	33.1	47.1	69.7

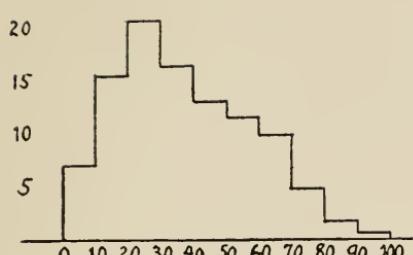


Fig. 1.

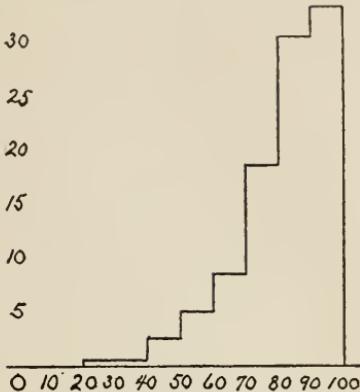


Fig. 4.

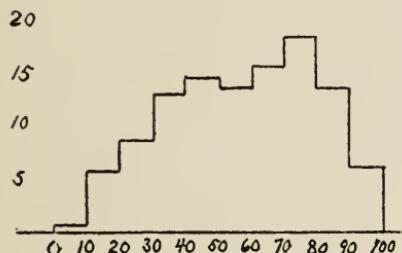


Fig. 2.

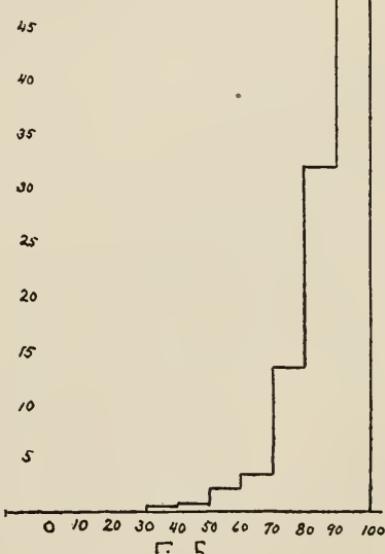


Fig. 5.

FIG. 1. Frequency of each rating (of per cent of Selected List spelled correctly) in grade 3.

FIG. 2. Frequency of each rating (of per cent of Selected List spelled correctly) in grade 4.

FIG. 3. Frequency of each rating (of per cent of Selected List spelled correctly) in grade 5.

FIG. 4. Frequency of each rating (of per cent of Selected List spelled correctly) in grade 6.

FIG. 5. Frequency of each rating (of per cent of Selected List spelled correctly) in grade 7.

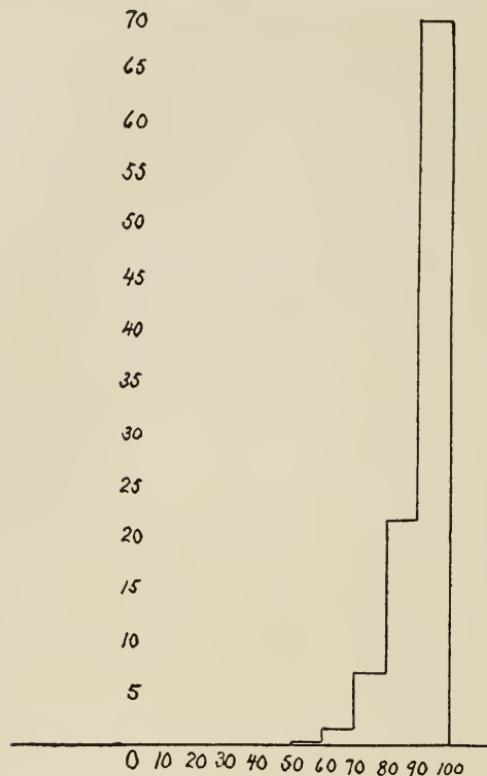


FIG. 6

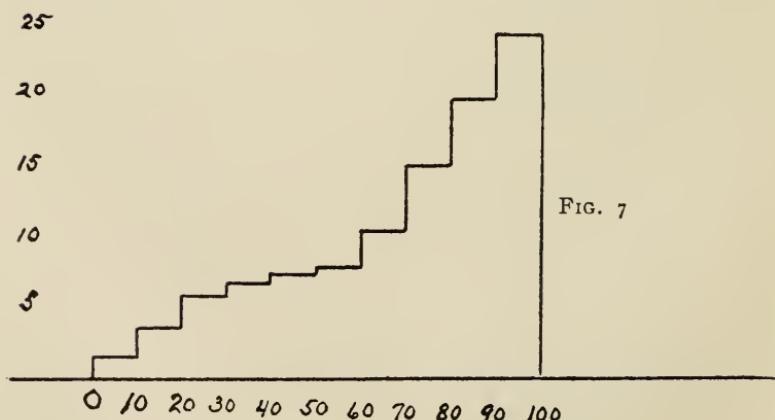


FIG. 7

FIG. 6. Frequency of each rating (of per cent of Selected List spelled correctly) in grade 8.

FIG. 7. Frequency of each rating (of per cent of Selected List spelled correctly) in grades 3-8 combined.

Another characteristic of the distributions shown in Table XI is the absence of clearly marked modes. Table XII is a grouping of the per cent columns of Table XI into 10's and 20's. From this grouping wide modes of marked character are shown.

Figs. 1 to 7 show the same facts graphically. From the nature of these figures the test material appears to have been capable of revealing satisfactorily the spelling ability of grades 3, 4, and 5. Figs. 1 to 7 are the surfaces of frequency of spelling ability with the Selected List. In each of them the horizontal scale shows percentages correct; the vertical scale shows the per cent of children having each rating for percentage correct, by steps of 10. The number of children represented is 445 in grade 3, 467 in grade 4, 515 in grade 5, 418 in grade 6, 365 in grade 7, and 277 in grade 8.

#### § 10. *Overlapping*

It follows as a matter of course from the variability of these ratings that the overlapping of grade on grade is conspicuous. We have located the median abilities, of each grade, for the selected word list. They are: 3d grade, 35.8; 4th grade, 60.7; 5th grade, 73.1; 6th grade, 84.9; 7th grade, 90.5; 8th grade, 94.7 (See Table XI). Table XIII shows the number of pupils and the per cent of pupils in each grade whose ratings equalled or exceeded the medians of every other grade. The table reads as follows: In the 3d grade 76 pupils equalled or exceeded the median rating of the 4th grade which was 17.1% of all the 3d-grade pupils; 27 equalled or exceeded the median rating of the 5th grade which was 6.1% of all the 3d-grade pupils. In the 4th grade 378 pupils equalled or exceeded the median rating of the 3d grade which was 80.9% of all the pupils of the 4th grade, etc. It will be noticed that there are two places where there is no overlapping. There are no 3d-grade children who equal the median rating of the 8th grade, although the 3 who exceed the 7th-grade median come very near it. Two of them are rated at 93 and one at 94, only 1.7 and .7 below the 8th-grade median. There is also no overlapping of the 8th grade on the 3d. All the pupils of the 8th grade exceed the median of the 3d grade. When, however, we say that at these points there is no overlapping, we do not mean that their surfaces of frequency do not enclose

TABLE XIII

NUMBER AND PER CENT OF PUPILS IN EACH GRADE WHOSE ABILITY  
EQUALLED OR EXCEEDED THAT OF THE MEDIAN PUPIL  
IN EVERY OTHER GRADE

		3d Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade
3d grade.....	No.	76	27	9	3	0	
N=445.....	%	17.1	6.1	2.0	0.7	0	
Med.=35.8							
4th grade.....	No.	378	146	52	27	9	
N=467.....	%	80.9	31.3	11.1	5.8	1.9	
Med.=60.7							
5th grade.....	No.	478	370	142	73	30	
N=515.....	%	92.8	71.8	27.6	14.2	5.8	
Med.=73.1							
6th grade.....	No.	414	384	338	142	57	
N=418.....	%	99.0	91.9	80.1	34.0	13.6	
Med.=84.9							
7th grade.....	No.	363	354	328	256	99	
N=365.....	%	99.5	96.4	89.9	70.1	27.1	
Med.=90.5							
8th grade.....	No.	277	276	269	241	200	
N=277.....	%	100	99.6	97.1	87.0	72.2	
Med.=94.7							

common areas. If Fig. 1 is placed on Fig. 8 so that the zero points coincide, it is evident that there is considerable area common to both. We mean that the upper part of the 3d-grade surface of frequency does not lap over *the median point* of the 8th-grade surface, and that the lower part of the 8th-grade surface does not reach down to the 3d-grade median. There are many 3d-grade children who do better than the poorest 8th-grade children.

The fact is, then, that except as between the 3d and 8th grades, some pupils of each grade perform like typical children of every other grade. Since this is true, it serves to fix the location of the frequency curves and medians for each grade with reference to each other. For the purpose of doing so we shall for the present assume that the distribution of spelling ability in each grade is "normal," i.e., is correctly represented by the curve of error.

There is some argument for this assumption. The fact that

our surfaces of frequency (Figs. 1-6) do not, especially for upper grades, closely resemble the normal curve, only shows that the test material was not difficult enough to bring out a distribution in real accordance with spelling ability. The result of using a different list of words is shown for grades 6, 7, and 8 by Figs. 8, 9, and 10. The test material in this instance was Rice's "Sentence Test": 396 children in the 6th grade, 367 in the 7th, and 244 in the 8th wrote this test in schools II, III, and VIII. The

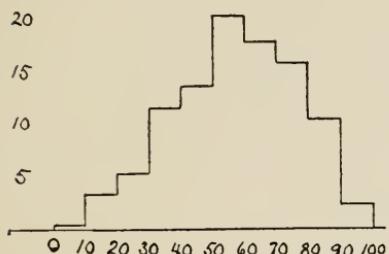


Fig. 8



Fig. 9



Fig. 10.

Figs. 8, 9 and 10. Frequency of each rating (of per cent of Rice Sentence List spelled correctly) in grades 6, 7 and 8, respectively.  $N=396$  for grade 6; 367 for grade 7; and 244 for grade 8. The horizontal scale is for per cent spelled correctly; the vertical scale is for the percentage of children receiving each rating for percentage correct, by steps of 10.

surface of frequency for the 6th grade is close to the "normal" surface. If that for the 7th and 8th grades is less so, it is still far more regular than the surfaces shown for these grades in Figs. 5 and 6 and might be made still more so by an appropriate selection of test material. There seems no good ground for as-

suming that the distribution of spelling ability in any grade is not according to the normal curve or according to a curve which resembles it closely.

### § 11. Location of Grade Medians

Upon the assumption, therefore, of a normal distribution we may proceed to locate the grade medians with reference to each other. In all cases we shall work with per cents instead of with numbers of pupils. This will reduce all surfaces of frequency to equal areas. We shall assume further that the real variability of any one of these grades in spelling ability is equal to the real variability of any other one of them.

We have already seen (Table XIII) that 17.1% of the 3d-

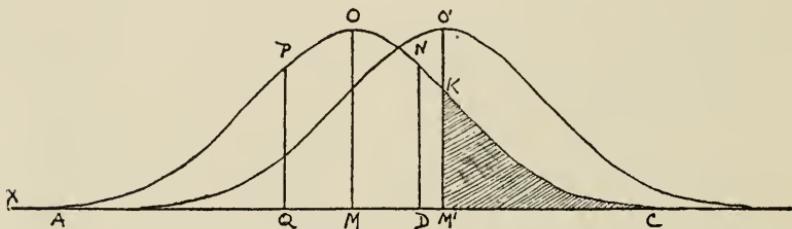


FIG. 11. Showing the overlapping of the 3d and 4th grade surfaces of frequency.

grade pupils equal or exceed the median ability of 4th-grade children. Fig. 11 shows this fact by a diagram. The surface on the left (Axis  $OM$ ) represents the 3d-grade distributions.  $M$  is its median point,  $MD$  ( $= MQ$ ) is its probable error—i.e., figure  $NPQD$  is one-half its area, thus graphically representing one-half the cases in the 3d grade, which accordingly do not deviate from the median by an amount greater than  $MD$ . The surface on the right represents the 4th-grade distribution beyond whose median axis,  $O^1M^1$ , the 3d-grade surface extends to an amount represented by the shaded figure  $KCM^1$ . This stands for the 3d-grade children who equal or exceed the 4th-grade median—i.e., it is 17.1% of the 3d-grade surface of frequency. Accordingly the area  $OKM^1M$  represents 32.9% of the cases. The distance  $MM^1$  may now be found in terms of P.E. It is the distance from the median point along the  $X$ -axis of the normal probability integral which includes 32.9% of the cases. Distances

corresponding to different per cents of the total area of the curve have been worked out. Table XIV, which is taken from

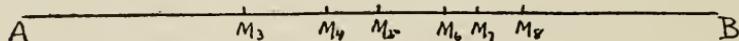
TABLE XIV

TABLE OF VALUES OF THE NORMAL PROBABILITY INTEGRAL CORRESPONDING TO VALUES OF P.E. TOTAL AREA OF THE SURFACE OF FREQUENCY TAKEN AS 10,000

$\frac{X}{P.E.}$	No. Cases	$\Delta$									
0	0		1.5	3441	81	3.00	4785	18	4.5	4988	1
.05	135	135	1.55	3521	80	3.05	4802	17	4.55	4989	1
.1	269	134	1.6	3597	76	3.1	4817	15	4.6	4990	1
.15	403	134	1.65	3671	74	3.15	4831	14	4.65	4991	1
.2	536	133	1.7	3742	71	3.2	4845	14	4.7	4992	1
.25	670	134	1.75	3811	69	3.25	4858	13	4.75	4993	1
.3	802	132	1.8	3876	65	3.3	4870	12	4.8	4994	
.35	933	131	1.85	3939	63	3.35	4881	11	4.85	4994.6	.6
.4	1063	130	1.9	4000	61	3.4	4891	10	4.9	4995.2	.6
.45	1193	130	1.95	4057	57	3.45	4900	9	4.95	4995.7	.5
.5	1321	128	2.0	4113	56	3.5	4909	9	5.0	4996.2	.5
.55	1447	126	2.05	4166	53	3.55	4917	8	5.05	4996.6	.4
.6	1571	124	2.1	4217	51	3.6	4924	7	5.1	4997.1	.5
.65	1695	121	2.15	4265	48	3.65	4931	6	5.15	4997.4	.3
.7	1816	119	2.2	4311	43	3.7	4937	6	5.2	4997.7	.3
.75	1935	118	2.25	4354	42	3.75	4943	5	5.25	4998.0	.2
.8	2053	115	2.3	4396	39	3.8	4948	5	5.3	4998.2	.2
.85	2168	113	2.35	4435	37	3.85	4953	4	5.35	4998.4	.2
.9	2281	111	2.4	4472	36	3.9	4957	4	5.4	4998.6	.2
.95	2392	108	2.45	4508	33	3.95	4961	4	5.45	4998.8	.2
1.0	2500	106	2.5	4541	32	4.0	4965	3	5.5	4999.0	.1
1.05	2606	103	2.55	4573	29	4.05	4968	3	5.55	4999.1	.1
1.1	2709	101	2.6	4602	29	4.1	4971	3	5.6	4999.2	.1
1.15	2810	98	2.65	4631	26	4.15	4974	3	5.65	4999.3	.1
1.2	2908	96	2.7	4657	25	4.2	4977	2	5.7	4999.4	.1
1.25	3004	93	2.75	4682	23	4.25	4979	2	5.75	4999.5	.05
1.3	3097	91	2.8	4705	22	4.3	4981	2	5.8	4999.55	.05
1.35	3188	87	2.85	4727	21	4.35	4983	2	5.85	4999.6	.05
1.4	3275	85	2.9	4748	19	4.4	4985	2	5.9	4999.65	.05
1.45	3360		2.95	4767	19	4.45	4987		5.95	4999.7	.05

Thorndike ('13, p. 200), presents these distances in units of P.E. By reference to it we find that 32.9% corresponds to 1.4088 P.E.

In a similar way, the 6.1% of 3d-grade children who equal or exceed the 5th-grade median (Table XIII) serve to locate that median at 2.2929 P.E. above the 3d-grade median. The 6th-grade median is 3.0441 P.E. and the 7th, 3.6429 P.E. above the 3d-grade median. The distance between the 3d- and 8th-grade medians cannot be directly calculated owing to the absence of sufficient overlapping.



Suppose the line *AB* to represent the range of spelling ability in the elementary school. At a certain distance above *A*, the absolute zero-point, stands the 3d-grade median,  $M_3$ . Above it and at distances to be determined are the medians of the 4th to the 8th grades,  $M_4$ — $M_8$ . For brevity we shall call the distance from the 3d- to the 4th-grade median  $M_{3-4}$ , etc.  $M_{4-3}$  means the same distance as  $M_{3-4}$ , but measured in the opposite or negative direction.

TABLE XV  
THE PER CENT OF PUPILS IN EACH GRADE WHOSE ABILITY EQUALLED  
OR EXCEEDED THAT OF THE MEDIAN PUPIL IN EVERY OTHER  
GRADE; WITH THE P.E. VALUES CORRESPOND-  
ING TO EACH PER CENT

		3d Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade
3d grade....	% P.E.		17.1 1.4088	6.1 2.2929	2.0 3.0441	0.7 3.6429	0 ?
4th grade...	% P.E.	80.9 —1.2962		31.3 .7227	11.1 1.8111	5.8 2.3308	1.9 3.0767
5th grade ..	% P.E.	92.8 —2.1663	71.8 —.8553		27.6 .8819	14.2 1.5888	5.8 2.3308
6th grade...	% P.E.	99.0 —3.4500	91.9 —2.0735	80.1 —1.2532		34.0 .6117	13.6 1.6291
7th grade ..	% P.E.	99.5 —3.8200	96.4 —2.6673	89.9 —1.8918	70.1 —.7818		27.1 .9041
8th grade ..	% P.E.	100 ?	99.6 —3.9375	97.1 —2.8114	87.0 —1.6704	72.2 —.8730	

Table XV gives all the distances between medians which our data permit us to calculate directly. The P.E. values, reading across the table, indicate that on the record of the pupils tested the 4th-grade median is found to be 1.4088 P.E. above the 3d-grade median, the 5th 2.2929 P.E. above it, the 6th 3.0441 P.E. above it, and the 7th 3.6429 P.E. above it; that the 3d-grade median is 1.2962 P.E. *below* the 4th-grade median, the 5th .7227 P.E. above it, etc.

It will be seen that  $M_4$  is given as 1.4088 above  $M_3$ , while  $M_3$  is given as only 1.2962 below  $M_4$ . We shall have to adopt one or the other, or some value between them as the most probably correct distance,  $M_{3-4}$ . Similarly for each of the other distances (except  $M_{3-8}$ ) we have two values, and these two values are in each case somewhat different one from the other. The following are the pairs of values which Table XV shows:

$M_{3-4}$	1.4088	and	1.2962
$M_{3-5}$	2.2929	"	2.1663
$M_{3-6}$	3.0441	"	3.4500
$M_{3-7}$	3.6429	"	3.8200
$M_{4-5}$	.7227	"	.8553
$M_{4-6}$	1.8111	"	2.0735
$M_{4-7}$	2.3308	"	2.6673
$M_{4-8}$	3.0767	"	3.9375
$M_{5-6}$	.8819	"	1.2532
$M_{5-7}$	1.5888	"	1.8918
$M_{5-8}$	2.3308	"	2.8114
$M_{6-7}$	.6117	"	.7818
$M_{6-8}$	1.6291	"	1.6704
$M_{7-8}$	.9041	"	.8730

The differences between these pairs of values is in most cases small. In all cases they afford data for the determination of the distances between medians which will be probably more accurate than either of them.

We do not, however, need all these values. If we have five, namely,  $M_{3-4}$ ,  $M_{4-5}$ ,  $M_{5-6}$ ,  $M_{6-7}$ , and  $M_{7-8}$ , all the others may be obtained by adding these together. We shall therefore attempt to derive as accurately as possible these five values in terms of the unit, P.E. Each of them is represented directly by two quantities as shown above. But it is clear that if we use more of the data of Table XV we may obtain values whose

accuracy will be much more satisfactory. We may, for instance, find for the distance between the 4th-grade median and the 5th-grade median ( $M_{4-5}$ ) a third value by subtracting from the distance between the 3d- and 5th-grade medians ( $M_{3-5} = .2929$ ) the distance between the 3d- and 4th-grade medians ( $M_{3-4} = .1088$ ). This gives .8841. Another value is the difference between the same two distances expressed negatively, i.e., according to our notation, between  $M_{5-3}$  (.1663) and  $M_{4-3}$  (.12962), which is .8701. Again we may use the difference between  $M_{4-6}$  and  $M_{5-6}$ , between  $M_{4-7}$  and  $M_{5-7}$ , between  $M_{4-8}$  and  $M_{5-8}$ ; and for each of these differences between positive quantities we have a difference between corresponding negative quantities. This adds six more expressions, making ten altogether, for the same distance,  $M_{4-5}$ . This is of course only a beginning of the great number of combinations which may be used to get expressions for the same distance. We think these few, however, since they use each of the 18 segments (nine counted both ways) which terminate at either  $M_4$  or  $M_5$  will be sufficient to determine  $M_{4-5}$  with considerable accuracy. We doubt whether the remoter segments (e.g.,  $M_{6-7}$ ,  $M_{6-8}$ , and  $M_{7-8}$ ) would, if used, increase the accuracy at all.

Accordingly we have calculated 10 values for  $M_{4-5}$ ,  $M_{5-6}$ , and  $M_{6-7}$ . Since we have no expression of direct relation between  $M_3$  and  $M_8$ , we have but 8 values for  $M_{3-4}$  and  $M_{7-8}$ . Table XVI gives all these values with the derivation of each. It also gives the averages, unweighted and weighted, of the values for each of the five median intervals.

It was felt that to give each of these items the same weight was to fail to take account of their reliability. The direct values are, no doubt, most to be depended upon. Those computed by using a distance which passes over one median are less so. Those involving two or more of these "skips" are still less so and diminish in reliability as the number of "skips" increases. It will be found that in column 2 of Table XVI the first quantity .8841 is derived by using a value that involves one skip.  $M_{3-5}$  skips over  $M_4$ , while  $M_{3-4}$ , which is taken from it, presents no skips. The second quantity, .7227, is direct, and there are no skips. .9292 involves one skip, .7420 three skips ( $M_{4-7}$  skips  $M_5$  and  $M_6$ , and  $M_{5-7}$  skips  $M_6$ ), etc. It will be found upon trial

TABLE XVI

DIRECT AND DERIVED VALUES OF MEDIAN DISTANCES IN TERMS OF P.E.

<i>A</i>	<i>M<sub>3</sub></i>	<i>M<sub>4</sub></i>	<i>M<sub>5</sub></i>	<i>M<sub>6</sub></i>	<i>M<sub>7</sub></i>	<i>M<sub>8</sub></i>	<i>B</i>
	<i>1.357</i>	<i>1.098</i>	<i>1.051</i>	<i>0.661</i>	<i>0.910</i>		

	<i>M<sub>3-4</sub></i>	<i>M<sub>4-5</sub></i>	<i>M<sub>5-6</sub></i>	<i>M<sub>6-7</sub></i>	<i>M<sub>7-8</sub></i>	
	<i>1.4088</i> (direct)	<i>.8841</i> ( <i>M<sub>3-5</sub></i> — <i>M<sub>3-4</sub></i> )	<i>.7512</i> ( <i>M<sub>3-6</sub></i> — <i>M<sub>3-5</sub></i> )	<i>.5988</i> ( <i>M<sub>3-7</sub></i> — <i>M<sub>3-6</sub></i> )	<i>?</i> ( <i>M<sub>3-8</sub></i> — <i>M<sub>3-7</sub></i> )	
	<i>1.5704</i> ( <i>M<sub>3-5</sub></i> — <i>M<sub>4-5</sub></i> )	<i>.7227</i> (direct)	<i>1.0884</i> ( <i>M<sub>4-6</sub></i> — <i>M<sub>4-5</sub></i> )	<i>.5199</i> ( <i>M<sub>4-7</sub></i> — <i>M<sub>4-6</sub></i> )	<i>.7459</i> ( <i>M<sub>4-8</sub></i> — <i>M<sub>4-7</sub></i> )	
	<i>1.2330</i> ( <i>M<sub>3-6</sub></i> — <i>M<sub>4-6</sub></i> )	<i>.9292</i> ( <i>M<sub>4-6</sub></i> — <i>M<sub>5-6</sub></i> )	<i>.8819</i> (direct)	<i>.7069</i> ( <i>M<sub>5-7</sub></i> — <i>M<sub>5-6</sub></i> )	<i>.7420</i> ( <i>M<sub>5-8</sub></i> — <i>M<sub>5-7</sub></i> )	
	<i>1.3121</i> ( <i>M<sub>3-7</sub></i> — <i>M<sub>4-7</sub></i> )	<i>.7420</i> ( <i>M<sub>4-7</sub></i> — <i>M<sub>5-7</sub></i> )	<i>.9771</i> ( <i>M<sub>5-7</sub></i> — <i>M<sub>6-7</sub></i> )	<i>.6117</i> (direct)	<i>1.0174</i> ( <i>M<sub>6-8</sub></i> — <i>M<sub>6-7</sub></i> )	
	<i>?</i> ( <i>M<sub>3-8</sub></i> — <i>M<sub>4-8</sub></i> )	<i>.7459</i> ( <i>M<sub>4-8</sub></i> — <i>M<sub>5-8</sub></i> )	<i>.7017</i> ( <i>M<sub>5-8</sub></i> — <i>M<sub>6-8</sub></i> )	<i>.7250</i> ( <i>M<sub>6-8</sub></i> — <i>M<sub>7-8</sub></i> )	<i>.9041</i> (direct)	
	<i>1.2962</i> (direct)	<i>.8701</i> ( <i>M<sub>5-3</sub></i> — <i>M<sub>4-3</sub></i> )	<i>1.2837</i> ( <i>M<sub>6-3</sub></i> — <i>M<sub>5-3</sub></i> )	<i>.3700</i> ( <i>M<sub>7-3</sub></i> — <i>M<sub>6-3</sub></i> )	<i>?</i> ( <i>M<sub>8-3</sub></i> — <i>M<sub>7-3</sub></i> )	
	<i>1.3110</i> ( <i>M<sub>5-3</sub></i> — <i>M<sub>5-4</sub></i> )	<i>.8553</i> (direct)	<i>1.2182</i> ( <i>M<sub>6-4</sub></i> — <i>M<sub>5-4</sub></i> )	<i>.5938</i> ( <i>M<sub>7-4</sub></i> — <i>M<sub>6-4</sub></i> )	<i>1.2702</i> ( <i>M<sub>8-4</sub></i> — <i>M<sub>7-4</sub></i> )	
	<i>1.3765</i> ( <i>M<sub>6-3</sub></i> — <i>M<sub>6-4</sub></i> )	<i>.8203</i> ( <i>M<sub>6-4</sub></i> — <i>M<sub>6-5</sub></i> )	<i>1.2532</i> (direct)	<i>.6386</i> ( <i>M<sub>7-5</sub></i> — <i>M<sub>6-5</sub></i> )	<i>.9196</i> ( <i>M<sub>8-5</sub></i> — <i>M<sub>7-5</sub></i> )	
	<i>1.1527</i> ( <i>M<sub>7-3</sub></i> — <i>M<sub>7-4</sub></i> )	<i>.7755</i> ( <i>M<sub>7-4</sub></i> — <i>M<sub>7-5</sub></i> )	<i>1.1100</i> ( <i>M<sub>7-5</sub></i> — <i>M<sub>7-6</sub></i> )	<i>.7818</i> (direct)	<i>.8886</i> ( <i>M<sub>8-6</sub></i> — <i>M<sub>7-6</sub></i> )	
	<i>?</i> ( <i>M<sub>8-3</sub></i> — <i>M<sub>8-4</sub></i> )	<i>1.1261</i> ( <i>M<sub>8-4</sub></i> — <i>M<sub>8-5</sub></i> )	<i>1.1410</i> ( <i>M<sub>8-5</sub></i> — <i>M<sub>8-6</sub></i> )	<i>.7974</i> ( <i>M<sub>8-6</sub></i> — <i>M<sub>8-7</sub></i> )	<i>.8730</i> (direct)	
Average	1.3326	.8471	1.0406	.6344	.9201	
Weighted Average	1.3505	.8363	1.0505	.6608	.9101	

that in all values there are either 0, 1, 3, or 5 skips. We have weighted them 6, 4, 3, and 2 respectively (ratio about 1.5). This is, of course, pure assumption, nor do we know of any convenient plan of weighting which would not be. All we can

say is that to us the direct values seem to be quite one and one-half times as reliable as those involving a distance which passes over one median, that it seems reasonable the latter should be about as many times more reliable than those involving 3 skips, and that the derivation with 5 skips would be inferior in approximately the same ratio. Weighting therefore as above indicated, we obtain values for the median distances as given in the last line of Table XVI. These are the measures that will be used in this study; but they differ so little from those obtained without weighting that the latter may serve almost as well.

Concretely these results mean that if we represent the difference between no spelling ability at all and the ability of typical 3d-grade children by  $x$ , the ability of typical 4th-grade children will be represented by  $x + 1.351$ , of typical 5th-grade children by  $x + 1.351 + .836$  or  $x + 2.187$ , of typical 6th-grade children by  $x + 3.238$ , of typical 7th-grade children by  $x + 3.899$ , and of typical 8th-grade children by  $x + 4.809$ . (The determination of the value of  $x$  is not material in the present connection. We shall, however, have something to offer on this point in a later section.) The median distances suggest that so far as spelling is concerned the equal time intervals of one year between the grades do not at all correspond to the differences in ability. The difference between 3d-grade performance and 4th-grade performance is more than twice as great as the difference between 6th- and 7th-grade performance. Whether this is due to a more or less common failure in the 7th grade to give as much attention to spelling as in earlier grades or whether in general 6th and 7th grades are actually closer together than others, is a question which we cannot settle. That a lack of effort to instruct in spelling in the higher grades does not fully account for the differences is suggested by the fact that the 8th grade stands at a greater distance from the 7th than the 5th does from the 4th or the 7th from the 6th.

### § 12. *Scaling the Words*

Assuming that the normal surface of frequency represents the distribution of spelling ability in each grade, we shall now seek to determine how difficult each one of the 50 words listed

in Tables III and IV is for each grade. A word spelled by one hundred per cent of the pupils in, say, the 3d grade would have no difficulty for that grade. The ability of all pupils would be greater than the ability required to spell it, and the entire area of the frequency surface would lie above it—i.e., to the right of it. In Fig. 12, if  $OP$  represents the Probable Error, it would be located theoretically at an indefinite distance to the left of the point  $O$ , a distance, however, which we may for practical purposes call 5 or 6 times as great as  $OP$ —i.e., 5 P.E. or 6 P.E. A word spelled by 98 per cent of the pupils becomes more intelligible. It would be located at a point  $K$ , a vertical at which  $(KL)$  would cut off 2 per cent of the area of the entire frequency surface. The point  $K$  will be found to be at a distance

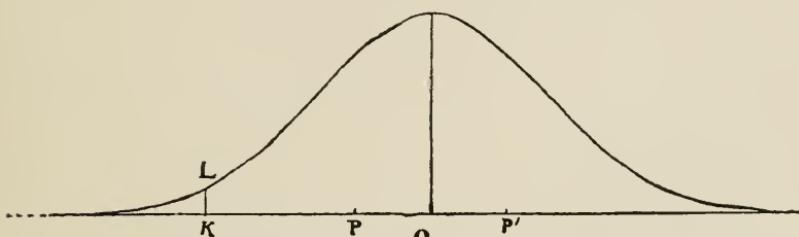


FIG. 12. Normal Surface of Frequency.

of about 3 P.E. below the median  $O$ , i.e., at 3 P.E. A word spelled by nobody—i.e., a word rated at 0—would be at, say, +6 P.E., and a word spelled correctly by 50 per cent of the group would be located at the median  $O$ , that is, at a point above and below which are an equal number of cases.

It will be interesting and will serve to show the misleading character of per cent ratings to observe what we mean by saying that one word is more difficult than another. Observe the two following groups of words taken from Tables III and IV for the 3d grade:

(A)	PER CENT CORRECT	(B)	PER CENT CORRECT
tailor.....	38	beautiful.....	10
lesson.....	37	beginning.....	9
another.....	36	telephone.....	8
wear.....	35	pigeons.....	7

According to the ratings of these words the differences in point of difficulty between the words of group A are equal to the differences in group B, for the differences are all represented by 1 per cent. Habitually we are likely to think that this is true. But such a way of thinking quite neglects the form of distribution of spelling ability. In fact it assumes that the frequency surface is a rectangle—i.e., that there are just as many very poor or very good spellers as there are spellers of medium ability. This we know is not true. The mediocre are always much more numerous than the dull or the gifted. A figure such as Fig. 12 takes account of this fact.

Now the words in group A are much nearer the median (which would be a word 50% correct) than are those of group B. They are located on the base line at points such that between adjacent verticals drawn at these points one per cent of the area will lie. The words of group B, more remotely placed with reference to the median, are also so situated that between their adjacent verticals one per cent of the area will lie. But the points for group B stand at greater distances apart than do the points for group A because the verticals or ordinates are shorter for the remoter group. As a matter of fact, the difference in difficulty between "beautiful" and "pigeons" is more than twice as much as the difference in difficulty between "tailor" and "wear," although each difference is represented by the same per cent.

Bearing in mind the meaning of these per cent values we may readily place the 50 words of Tables III and IV along the  $x$ -axis or base line of a normal frequency surface. "Even," which is rated 59 per cent for the 3d grade, would be at a point *below* the median between whose ordinate and the median ordinate is 9% of the area of the surface. Calling the median zero and referring to Table XIV, we find that 9% of the cases (900 in 10,000) corresponds to a value of P.E. which lies between .3 and .35. By interpolation this value is found to be .338. Therefore the position of "even" is at —.338 P.E. This may be represented on Fig. 13 by the point 1. "Lesson" (37% correct) will be at a point *above* zero between which and zero are 13% of the cases of a normal frequency surface. Table XIV locates this point at +.49 P.E. (Point 2, Fig. 13). "Only" (65%

correct) is at  $-.572$  P.E. (Point 3, Fig. 13); "smoke" (46%) at  $.148$  P.E. (point 4); "pear" (31%) at  $.735$  P.E. (point 5); "minute" (26%) at  $.955$  P.E. (point 6); "cousin" (19%) at  $1.300$  P.E. (point 7), and so on. Words rated above 50% are located below the median: those under 50% are above the median. Their distances from the median are negative in the first case and positive in the second.

Assuming the same form of distribution for the 4th grade we find that "even" (79%) is located at  $-1.20$  P.E., "only" (75%) at precisely  $-1.00$  P.E., and "pear" (42%) at  $.30$  P.E. Similarly for each grade by using the per cents of Table III and IV and the P.E. equivalents of Table XIV we may "place" all

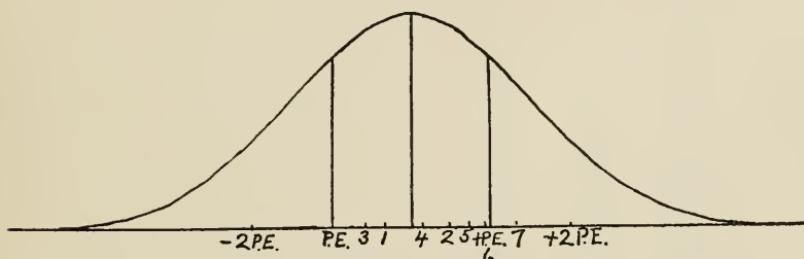


FIG. 13. Showing the placing of the first 7 words of the Preferred List, 3d grade.

the words. Table XVII gives the per cents and P.E. equivalents of the 50 words of the Preferred Lists which from now on will be treated as one list. Figs. 14, 15, 16, 17, 18 and 19 show how the words appear when arranged on a linear scale for each grade. For the meanings of the numbers, each of which refers to a word of the Preferred List, see Table XVII or Appendix II.

Table XVII with its corresponding figures (14 to 19) affords standards for grade performances. As will be observed, the P.E. values of all the words are calculated for each grade with reference to the median of that grade, which is called zero. Their use may be illustrated with reference to the 4th grade. We may test a pupil of that grade by beginning with the easiest word and proceeding to the next hardest and the next and so on. The series would run: 1 *even*, 3 *only*, 2 *lesson*, or 5 *front*, 28 *chicken*, or 41 *Tuesday*, 4 *smoke*, 11 *pretty*, 8 *bought*. . . . By the time



TABLE XVII

PER CENTS CORRECT AND P.E. EQUIVALENTS FOR EACH WORD OF THE PREFERRED LIST. GRADES 3-8. SEE FIGS. 14-19

No. of Word	Words	3d Year		4th Year		5th Year		6th Year		7th Year		8th Year							
		%	P.E.	%	P.E.	%	P.E.	%	P.E.	%	P.E.	%	P.E.						
1	even.....	59	—	.337	79	—	1.196	89	—	1.819	93	—	2.188	97	—	2.789			
2	lesson.....	37	+	.492	72	—	.864	83	—	1.415	91	—	1.988	94	—	2.305	96	—	2.597
3	only.....	65	—	.571	75	—	1.000	89	—	1.819	95	—	2.439	97	—	2.789	99	—	3.450
4	smoke.....	46	+	.139	69	—	.735	85	—	1.537	94	—	2.305	96	—	2.597	99	—	3.450
5	front.....	51	—	.037	72	—	.864	80	—	1.248	90	—	1.900	94	—	2.305	97	—	2.789
6	sure.....	47	+	.112	55	—	.187	69	—	.735	78	—	1.145	89	—	1.819	94	—	2.305
7	pear.....	31	+	.735	42	+	.299	58	—	.299	72	—	.864	81	—	1.302	94	—	2.305
8	bought.....	40	+	.376	65	—	.571	79	—	1.196	91	—	1.988	94	—	2.305	97	—	2.789
9	another.....	36	—	.531	43	—	.261	78	—	1.145	86	—	1.602	94	—	2.305	96	—	2.597
10	forty.....	49	+	.037	62	—	.453	65	—	.571	72	—	.864	83	—	1.415	87	—	1.670
11	pretty.....	45	+	.187	67	—	.652	76	—	1.047	90	—	1.900	90	—	1.900	94	—	2.305
12	wear.....	35	—	.571	49	—	.037	61	—	.414	74	—	.954	84	—	1.473	93	—	2.188
13	button.....	32	—	.693	52	—	.074	61	—	.414	73	—	.909	74	—	.954	87	—	1.670
14	minute.....	26	—	.954	38	+	.453	62	—	.453	77	—	1.096	86	—	1.602	92	—	2.083
15	cousin.....	19	+	1.302	47	—	.112	69	—	.735	89	—	1.819	89	—	1.819	95	—	2.439
16	nails.....	43	+	.261	58	—	.299	71	—	.820	87	—	1.670	92	—	2.083	96	—	2.597
17	janitor.....	19	+	1.302	42	+	.299	58	—	.299	81	—	1.302	81	—	1.302	90	—	1.900
18	saucer.....	11	+	1.819	29	—	.820	42	+	.299	58	—	.299	79	—	1.196	81	—	1.302
19	stopping.....	27	+	.909	39	—	.414	55	—	.187	71	—	.820	76	—	1.047	84	—	1.475
20	sword.....	13	+	1.670	46	+	.149	57	—	.261	78	—	1.145	86	—	1.602	93	—	2.188
21	freeze.....	29	+	.820	46	+	.149	68	—	.693	83	—	1.415	86	—	1.602	94	—	2.305
22	touch.....	45	+	.187	52	—	.074	60	—	.376	81	—	1.302	84	—	1.473	93	—	2.188
23	whistle.....	22	+	1.145	55	—	.187	56	—	.224	64	—	.531	75	—	1.000	85	—	1.537
24	carriage.....	13	+	1.670	40	+	.376	50	—	.000	67	—	.652	81	—	1.302	85	—	1.537
25	nor.....	63	—	.492	61	—	.414	65	—	.571	68	—	.693	77	—	1.096	94	—	2.305
26	already.....	16	+	1.475	42	+	.299	43	+	.261	62	—	.453	44	+	.224	77	—	1.096
27	beginning.....	9	+	1.988	25	+	1.000	37	+	.492	46	+	.149	66	—	.612	75	—	1.000
28	chicken.....	49	—	.037	70	—	.778	83	—	.141	90	—	1.900	96	—	2.597	99	—	3.450
29	choose.....	22	+	1.145	34	+	.612	48	+	.074	60	—	.376	65	—	.571	82	—	1.357
30	circus.....	20	+	1.248	39	+	.414	50	—	.000	72	—	.864	75	—	1.000	95	—	2.439
31	grease.....	11	+	1.819	18	+	1.357	37	+	.492	35	+	.571	42	+	.299	57	—	.261
32	pigeons.....	7	+	2.188	29	—	.820	41	+	.337	57	—	.261	70	—	.778	82	—	1.357
33	quarrel.....	15	+	1.537	39	+	.414	53	—	.112	75	—	1.000	86	—	1.602	94	—	2.305
34	saucy.....	14	+	1.602	35	+	.571	40	+	.376	52	—	.074	71	—	.820	78	—	1.145
35	tailor.....	38	+	.453	55	—	.187	70	—	.778	75	—	1.000	81	—	1.302	84	—	1.475
36	telegram.....	15	+	1.537	31	+	.735	39	+	.414	63	—	.492	73	—	.909	84	—	1.475
37	telephone.....	8	+	2.083	35	+	.571	48	+	.074	67	—	.652	83	—	1.415	87	—	1.670
38	tobacco.....	12	+	1.742	39	—	.414	60	—	.376	75	—	1.000	88	—	1.742	96	—	2.597
39	too.....	14	+	1.602	28	—	.864	27	+	.909	24	+	1.047	30	+	.778	43	—	.261
40	towel.....	24	+	1.047	44	—	.224	64	—	.531	73	—	.909	78	—	1.145	94	—	2.305
41	Tuesday.....	46	+	.149	70	—	.778	67	—	.652	80	—	1.248	87	—	1.670	91	—	1.988
42	tying.....	44	—	.224	58	—	.299	70	—	.778	68	—	.693	76	—	1.047	87	—	1.670
43	whole.....	17	+	1.415	43	+	.261	64	—	.531	78	—	1.145	84	—	1.475	90	—	1.900
44	against.....	19	+	1.302	30	—	.778	54	—	.149	74	—	1.000	84	—	1.475	94	—	2.305
45	answer.....	27	+	.909	47	+	.112	67	—	.652	86	—	1.602	90	—	1.900	97	—	2.789
46	butcher.....	33	+	.652	59	—	.337	69	—	.735	85	—	1.537	90	—	1.900	97	—	2.789
47	guess.....	20	+	1.248	32	+	.693	49	+	.037	67	—	.652	77	—	.1096	85	—	1.537
48	instead.....	32	—	.693	48	—	.074	62	—	.453	86	—	1.602	87	—	1.670	91	—	1.988
49	raise.....	21	+	1.196	54	—	.149	67	—	.652	84	—	1.475	93	—	2.188	94	—	2.305
50	beautiful.....	10	+	1.900	52	—	.074	70	—	.778	85	—	1.537	94	—	2.305	96	—	2.597

we have reached 13 *button*, 22 *touch*, 50 *beautiful*, 12 *wear*, and 48 *instead*, we are dealing with a group of words which 50 per cent of 4th-grade children spell correctly. The performance of

a given 4th-grade pupil should approximate at least the standard set by these words. If we are asked, "What is 4th grade spelling ability?" we may answer that it is the ability to spell these words that cluster about the median. Of course it is to be expected that any given pupil will miss some of the easier words and spell some of the harder words. We should test him by the whole series of 50 and his errors for words below the median may be balanced against correct spellings of words above the median at an approximately equal distance. He may miss 49 *raise* (—.15 P.E.) but spell 20 *sword* or 21 *freeze* (+.15 P.E.). He may miss 16 *nails*, but spell 7 *pear*. In such cases he should be credited with having spelled the easier word.

In a similar way, by using the words in the order in which they are placed for any other grade, we may determine whether a child is as good a speller as the median children of that grade. We do not need, however, to use the median as a standard unless we wish to. We may choose + 40 or + 60 and ascertain whether children are able to spell up to that point in the same manner as is indicated above for the zero-point. It is to be observed, however, that our series does not offer a very satisfactory test in the higher grades for such standards, because there are so few words that are placed as high or higher than + 40 or + 60. The words, in short, are not difficult enough for this purpose. In a later section of the paper we shall introduce harder words into the series precisely with the object of affording a fuller test of ability for the higher grades.

There remains, however, for the present one other use which may be made of our data. We may wish to disregard grades altogether and seek an answer to the question, In general, how hard are these words for children of the elementary school above the 2d year? or, with reference to a graphical representation, What is the average position of each word on a linear scale—that position from which the positions for each grade deviate by the smallest amounts?

To answer such a question we shall have to use one point of reference for all grades instead of a different one for each grade. In the above treatment we have expressed each word-value as a deviation from the median of the particular grade we were considering. We shall now use this same data but

transfer the point of reference to the third-grade median by using the median intervals which were derived in Section II. In Table XVI (page 39) we have given the results of our inquiry into the amounts of these intervals as follows:

From $M_3$ to $M_4$	1.351 P.E.
“ $M_3$ “ $M_5$	2.187 “
“ $M_3$ “ $M_6$	3.238 “
“ $M_3$ “ $M_7$	3.899 “
“ $M_3$ “ $M_8$	4.809 “

Table XVIII gives, for each of the 50 words, its position for each grade when referred to the 3d-grade median as the zero-point or point of reference, together with the “average position” of each word. The method of securing these figures may be illustrated as follows:

From Table XVII the P.E. values of the word “even” for each grade, referred to its own median, are shown to be

3d grade,	— .337
4th “	—1.196
5th “	—1.819
6th “	—2.188
7th “	—2.188
8th “	—2.789

The first of these values is of course already referred to the 3d-grade median. To refer the others to the same point we must increase each of them by the amount by which each grade median stands above the 3d-grade median, i.e., we must find the sum (algebraic) of —1.196 and 1.351, of —1.819 and 2.187, of —2.188 and 3.238, of —2.188 and 3.899, and of —2.789 and 4.809. These sums give the figures of Table XVIII for the word “even.” Their arithmetical mean is taken as the average position.

Fig. 20 shows the averages of Table XVIII when reduced to a scale. The noticeable thing about these tabular and graphic representations is the fact that the words from easiest to hardest differ so little. The words “even” and “only” (No. 1 and No. 3), which are —.337 and —.571 respectively for the 3d grade, appear above the zero point at +.699 and +.569. Similarly the word “too” (No. 39) which for the 8th grade alone is + 5.07 becomes for all grades only + 3.491. It is a fact

TABLE XVIII

THE POSITION OF EACH WORD IN EACH GRADE WHEN REFERRED TO THE 3D-  
GRADE MEDIAN AS THE ZERO-POINT; AND THE AVERAGE POSITION OF  
EACH WORD FOR ALL GRADES, WHEN SO REFERRED. 1=P.E.

Word Number	Word	3d Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade	Average Position
1	even.....	—.337	.155	.368	1.050	1.711	2.020	.699
2	lesson.....	.492	.487	.772	1.250	1.594	2.212	1.135
3	only.....	—.571	.351	.368	.797	1.110	1.359	.569
4	smoke.....	.149	.616	.650	.933	1.302	1.359	.835
5	front.....	—.037	.487	.937	1.338	1.594	2.020	1.057
6	sure.....	.112	1.164	1.452	2.093	2.080	2.504	1.568
7	pear.....	.735	1.650	1.888	2.374	2.597	2.504	1.958
8	bought.....	.376	.780	.991	1.250	1.594	2.020	1.169
9	another.....	.531	1.612	1.042	1.636	1.594	2.212	1.078
10	forty.....	.037	.898	1.616	2.374	2.484	3.139	1.758
11	pretty.....	.187	.699	1.140	1.338	1.999	2.504	1.311
12	wear.....	.571	1.388	1.773	2.284	2.424	2.621	1.844
13	button.....	.693	1.277	1.733	2.329	2.945	3.139	2.026
14	minute.....	.954	1.804	1.734	2.142	2.297	2.726	1.943
15	cousin.....	1.302	1.463	1.452	1.419	2.080	2.370	1.681
16	nails.....	.261	1.052	1.367	1.568	1.816	2.212	1.379
17	janitor.....	1.302	1.650	1.888	1.936	2.597	2.909	2.047
18	saucer.....	1.819	2.171	2.486	2.939	2.703	3.507	2.604
19	stopping.....	.909	1.765	2.000	2.418	2.852	3.334	2.213
20	sword.....	1.670	2.500	1.926	2.093	2.297	2.621	2.185
21	freeze.....	.820	1.500	1.494	1.823	2.297	2.504	1.740
22	touch.....	.187	1.277	1.811	1.936	2.424	2.621	1.709
23	whistle.....	1.145	1.164	1.963	2.707	2.899	3.272	2.193
24	carriage.....	1.670	1.727	2.187	2.586	2.597	3.272	2.340
25	nor.....	—.492	.937	1.616	2.545	2.803	2.504	1.652
26	already.....	1.475	1.650	2.448	2.785	4.123	3.713	2.699
27	beginning.....	1.988	2.351	2.679	3.387	3.287	3.809	2.917
28	chicken.....	.037	.573	.772	1.338	1.302	1.359	.897
29	choose.....	1.145	1.963	2.261	2.862	3.328	3.452	2.502
30	circus.....	1.248	1.765	2.187	2.374	2.899	2.370	2.141
31	grease.....	1.819	2.708	2.679	3.809	4.198	4.548	3.294
32	pigeons.....	2.188	2.171	2.524	2.977	3.121	3.452	2.739
33	quarrel.....	1.537	1.765	2.075	2.238	2.297	2.504	2.069
34	saucy.....	1.602	1.922	2.563	3.164	3.079	3.664	2.666
35	tailor.....	.453	1.164	1.409	2.238	2.597	3.334	1.866
36	telegram.....	1.537	2.086	2.601	2.746	2.990	3.334	2.549
37	telephone.....	2.083	1.922	2.261	2.586	2.485	3.139	2.413
38	tobacco.....	1.742	1.765	1.811	2.238	2.157	2.212	1.988
39	too.....	1.602	2.215	3.096	4.285	4.677	5.070	3.491
40	towel.....	1.047	1.575	1.656	2.329	2.754	2.504	1.978
41	Tuesday.....	.149	.573	1.535	1.990	2.229	2.821	1.550
42	tying.....	.224	1.052	1.409	2.545	2.852	3.139	1.870
43	whole.....	1.415	1.612	1.656	2.093	2.424	2.909	2.018
44	against.....	1.302	2.129	2.038	2.238	2.424	2.504	2.106
45	answer.....	.909	1.463	1.535	1.636	1.999	2.020	1.594
46	butcher.....	.652	1.014	1.452	1.701	1.999	2.020	1.473
47	guess.....	1.248	2.044	2.224	2.586	2.803	3.272	2.363
48	instead.....	.693	1.425	1.734	1.636	2.229	2.821	1.756
49	raise.....	1.196	1.202	1.535	1.763	1.711	2.504	1.652
50	beautiful.....	1.900	1.277	1.409	1.701	1.594	2.212	1.682

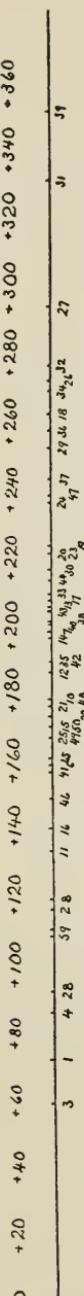


FIG. 20. The positions of each word of the Preferred List on a scale of difficulty for grades 3-8 together, o being the 3d-grade median and 100 being P.E. The Preferred List is as follows:

1. even
2. lesson
3. only
4. smoke
5. front
6. sure
7. pear
8. bought
9. another
10. forty
11. pretty
12. wear
13. button
14. minute
15. cousin
16. nails
17. janitor
18. saucer
19. stopping
20. sword
21. freeze
22. touch
23. whistle
24. carriage
25. nor
26. already
27. beginning
28. chicken
29. choose
30. circus
31. grease
32. pigeons
33. quarrel
34. saucy
35. tailor
36. telegram
37. telephone
38. tobacco
39. too
40. towel
41. Tuesday
42. tying
43. whole
44. against
45. answer
46. butcher
47. guess
48. instead
49. raise
50. beautiful

then that *for these words* the influence of higher grades is to make easy words harder and of lower grades to make hard words easier. That is, grade considered, these words are harder for children of the upper grades than they are for those of the lower grades. There are at least two reasons for this condition.

First, as a rule these particular words are taught in the lower grades. A popular speller, taken at random, presents 31 of the 50 words in the 3d year's work, 10 in the 4th, 2 in the 5th, and none in higher grades. There is nothing to lead one to suppose that this is peculiar. The words were among those chosen, it will be remembered, as at least in the speaking vocabulary of 3d-grade children. Most of them if taught at all will be taught in that grade. We may assume therefore that the 3d-grade record is somewhat affected by the recency with which these words have been presented. The succeeding grades will to some extent be discriminated against in the record.

Second, the necessary basis of selection for these words from the larger lists would make it impossible for the words to take the same position on the scale for all grades. Consider a word which was spelled correctly by 50% of the 3d-grade children. Such a word would be at  $M_3$ . In order to take the same position on the 8th-grade record it must be as far below  $M_8$  as is the distance, already determined, between  $M_3$  and  $M_8$  or —4.809 P.E. To do this it would have to be spelled correctly by 9994 pupils out of 10,000 (Table XIV), i.e., it would be 100% correct. But such a word would not have been selected, because it is not difficult enough in the 8th grade to be of any value as a test of ability. On the other hand, a word missed often enough in the 8th grade to be satisfactory as a test (say, 90% correct) would have to be less than 1% correct on the 3d-grade record in order to take the same position on the scale. Such a word would have been of no use as testing 3d-grade ability and would have been rejected.

The fact is that the span from 3d to 8th grade is—if our median distances be correct—too great for any list of words to be in all respects satisfactory. We need several lists each of which shall be given to three or four consecutive grades and overlapping on one another—e.g., one for 2d, 3d, and 4th grades, another

for 3d, 4th, 5th and 6th grades, and another for 5th, 6th, 7th and 8th grades. An attempt will be made in a later section to do this and to show the results that may be expected.

### § 13. *The Use of the Scale*

Meanwhile, however, we venture to think that the scale as shown in Fig. 20 is important and valid within its range. It may be used in several ways of which at least three are important.

1. It may be used just as it is without reference to the fact that the words are not separated from each other by equal intervals. We know the value or weight to assign to each word. We shall therefore not make the mistake of assuming that all the words are of the same value, as is the usual school practice.

2. Certain words of the series may be used which differ from each other by approximately equal steps.

TABLE XIX  
WORDS ARRANGED IN ORDER OF DIFFICULTY ACCORDING TO THE SCALE  
AND THEIR P.E. VALUES

No. on Scale	Word	P.E. x 100	No. on Scale	Word	P.E. x 100
3	only . . . . .	57	14	minute . . . . .	194
1	even . . . . .	70	7	pear . . . . .	196
4	smoke . . . . .	84	40	towel . . . . .	198
28	chicken . . . . .	90	38	tobacco . . . . .	199
5	front . . . . .	106	43	whole . . . . .	202
9	another . . . . .	108	13	button . . . . .	203
2	lesson . . . . .	114	17	janitor . . . . .	205
8	bought . . . . .	117	33	quarrel . . . . .	207
11	pretty . . . . .	131	44	against . . . . .	211
16	nails . . . . .	138	30	circus . . . . .	214
46	butcher . . . . .	147	20	sword . . . . .	219
41	Tuesday . . . . .	155	23	whistle . . . . .	219
6	sure . . . . .	157	19	stopping . . . . .	221
45	answer . . . . .	159	24	carriage . . . . .	234
25	nor . . . . .	165	47	guess . . . . .	236
49	raise . . . . .	165	37	telephone . . . . .	241
15	cousin . . . . .	168	29	choose . . . . .	250
50	beautiful . . . . .	168	36	telegram . . . . .	255
22	touch . . . . .	171	18	saucer . . . . .	260
21	freeze . . . . .	174	34	saucy . . . . .	267
10	forty . . . . .	176	26	already . . . . .	270
48	instead . . . . .	176	32	pigeons . . . . .	274
12	wear . . . . .	184	27	beginning . . . . .	292
35	tailor . . . . .	187	31	grease . . . . .	329
42	tying . . . . .	187	39	too . . . . .	349

3. Small groups of words may be so selected as to be equally difficult as groups; or they may be so selected that their group-difficulties constitute an ascending series from easy to hard, differing by equal amounts.

1. By the first of these methods the entire series would be utilized or so much of it as in any given case would thoroughly test the subject. The order of the words of the series as given in Figure 20 is shown in Table XIX in the first column and in the second column the test values or weights of these words are given.

2. If it is desired to use a scale whose words differ in difficulty by equal steps, the arrangement as shown in Table XX will be found convenient.

TABLE XX  
A TEN-POINT SCALE

No. of Word (Fig. 20)	Word	P.E. x 100	△
3	only.....	57	27
4	smoke.....	84	24
9	another.....	108	23
11	pretty.....	131	28
45	answer.....	159	28
35	tailor.....	187	27
30	circus.....	214	27
37	telephone.....	241	26
34	saucy.....	267	25
27	beginning.....	292	

To this series may be added 39 "too" whose P.E. x 100 is 349 and which differs from "beginning" by 57 or approximately two steps.

In the series of Table XX the average step is 26.2 with an A.D. of 1.3; or if the word "too" is included the average step is 26.6 with an A.D. of 1.4. This is quite accurate enough for any use to which the scale is likely to be put. If this conclusion

is accepted, these eleven words may be used to express our judgments of other words concretely and in terms that everybody can understand. We should not then have to resort to such terms as "hard," "easy," "rather difficult," "very hard," etc., but we may judge a word to be "as hard as 'another,'" "equal in difficulty to 'beginning,'" "as hard as 'answer' but not as hard as 'tailor,'" etc. It is very desirable that other words should at some time be added to the scale at both ends. There are many words harder than "beginning" or "too" and there are others easier than "only," although the latter do not constitute much of a school problem. Neither set, however, could be used over a range as wide as 3d to 8th grades.

3 (a). It is often desirable to offer tests of equal difficulty, but of different words at various intervals of time to the same group or to the same individual. We may thus secure a progress record. In spelling, however, this has proved to be very difficult if not impossible. We can never be sure that the second or third test is equal in difficulty to the first test. In fact we may be pretty sure it is not. To give the same words over again is often valueless because of the added special familiarity with them. The following lists therefore are offered as lists of equal difficulty. The sum of the P.E. values in each is 976 or 977. In using them the words may be weighted as indicated, or may, with no great loss in precision, be each given a credit of 1.

Number in Preferred List	Group A		Number in Preferred List	Group B	
		Weight			Weight
41	Tuesday.....	16	45	answer.....	16
10	forty.....	18	48	instead.....	18
40	towel.....	20	43	whole.....	21
44	against.....	22	17	janitor.....	21
47	guess.....	24	24	carriage.....	24
Group C					
49	raise.....	17	21	freeze.....	18
22	touch.....	17	12	wear.....	19
42	tying.....	19	7	pear.....	20
14	minute.....	20	13	button.....	21
18	saucer.....	27	20	sword.....	22
Group E					
16	nails.....	14	8	bought.....	12
46	butcher.....	15	11	pretty.....	13
15	cousin.....	17	19	stopping.....	23
29	choose.....	26	37	telephone.....	25
32	pigeons.....	28	34	saucy.....	27
Group F					

(b) It may also be desirable to test, not with single words, which only in the long run may be expected to conform to the positions assigned to them, but with groups of words whose difficulties as groups differ by constant amounts. Such a series of groups arranged from easy to hard would themselves constitute a scale—a sort of Binet-Simon scale for measuring ability in spelling. On the analogy of the Binet-Simon scale we might easily fix upon a certain minimum performance for a group at which or better than which a subject might be allowed to have "cleared" that group and might pass on to the next. He might also be given additional credits for spelling words in groups above the highest one which he cleared.

The groups are arranged in order of difficulty, Group I being the easiest and Group VII the hardest. Within each group the four words are also arranged in their order of difficulty beginning with the easiest. Since, however, within each group the words differ little in difficulty, they may be taken as having equal weights without material error. It is true that Group VII is not nearly as satisfactory in this respect as the others, differing between the first and fourth words by 1.08 P.E., whereas the first six groups have a range of but .225 on the average.

Group I		P.E. x 100	Group IV		P.E. x 100
3	only.....	57	10	forty.....	176
1	even.....	70	12	wear.....	184
4	smoke.....	84	42	tying.....	187
28	chicken.....	90	38	tobacco.....	199
Average.....		75	Average.....		186.5
Group II		P.E. x 100	Group V		P.E. x 100
5	front.....	106	33	quarrel.....	207
9	another.....	108	30	circus.....	214
2	lesson.....	114	24	carriage.....	234
8	bought.....	117	47	guess.....	236
Average.....		111	Average.....		223
Group III		P.E. x 100	Group VI		P.E. x 100
16	nails.....	138	29	choose.....	250
46	butcher.....	147	36	telegram.....	255
41	Tuesday.....	155	34	saucy.....	267
6	sure.....	157	26	already.....	270
Average.....		149	Average.....		260.5
Group VII		P.E. x 100			
37	telephone.....	241			
32	pigeons.....	274			
31	grease.....	329			
39	too.....	349			
Average.....		298			

The average differences in difficulty between these groups in succession are 36, 38, 37.5, 36.5, 37.5 and 37.5. This is probably the most important use of the scale, for present school practice.

If it is true that the general scale (Table XVIII and Fig. 20) may be used in these three ways—as a whole, by words selected to be at equal intervals, and by grouping words so that the groups are equal or differ by equal amounts—then it is also true that each of the grade scales (Figs. 14-19) may be used in like manner each for the grade to which it applies. It is probably true, moreover, that the grade scales will more closely fit real conditions in any given instance than will the scale for all grades. The labor of making selections and groupings of words for these scales is not great and may be made by any one on the analogy of the method used above.

#### § 14. *The Zero-Point of Spelling Ability*

As has been suggested in previous sections, we have only succeeded in scaling by means of these 50 words a limited segment of the entire projection representing spelling ability. Our list is essentially an easy list, testing that ability only to a moderate degree. Words like "fatiguing," "guarantee," and "conscientious" (Rice Sentence Test) would stand much higher in the scale and require a considerable extension of it to the right; while such unfamiliar words as "eurycerous," "delitescence," and "gallinaceous" (Klein, '12, pp. 388, 389) would take still higher positions, passing quite beyond the range of the ability of elementary-school children.

On the other hand, our scale is as certainly limited at the low end. There are many easier words than any we have used so far. Such words would reach far down on the scale towards the place where the absolute zero-point lies. But they would have been totally unfit for use in the higher grades. In fact, with the wide range of ability between 3d and 8th grades, it is surprising that we find any words at all which will afford a test at both extremes.

Without seeking to determine the limit of the high end of the scale—perfect spelling ability—it is quite possible, and theoretically very desirable, to find the limit of the low end, i.e.,

to find the point where spelling ability just begins to be a positive quantity.

How far, then, below the 3d-grade median, which has hitherto been our point of reference, is the absolute zero-point?

In order to answer this question, a test was given to children of the 2d, 3d, and 4th grades. It consisted of 50 words in sentences. Nineteen of these had already been used in the Selected List (100 word list); and, of these, 6 had been chosen for the Preferred List. They had all been spelled, about 40 per cent or more correct, by the third-grade children. The remaining 32 words were thought to be among the easiest in the language: he, is, on, the, to, of, for, day, etc.

They were put into sentences as follows and dictated at schools II and VIII:

#### EASY 50-WORD TEST

1. *You will hear him coming.*
2. *He is on the road and is almost sure to pass in front of me.*
3. *I send for him every day.*
4. *Go into the school.*
5. *But do not touch the table.*
6. *He also has only one pair of shoes.*
7. *They are not at all pretty.*
8. *No man ought to steal even a penny.*

It seems clear that a child who cannot spell *any one* of these words has substantially no spelling ability. Since our study is limited to written words we shall say, therefore, that for our purpose a child who does not, save by chance, write a single word of this list so that it can be recognized as correctly spelled has no ability.

On account of the marked improvement in spelling of children in the latter half of the second school year over those in the first half of that year, we have treated the two half-years of the 2d grade separately, calling the lower half *2a* and the upper *2b*. We shall proceed as follows. We shall find the distance between the 3d-grade median and the *2b*-grade median and the distance between the latter and the *2a*-grade median. Then if there are children of the *2a* grade who utterly break down and

fail to write any word correctly we shall find their place in the *2a* distribution.

Table XXI shows the records of individual pupils according to their rating in the Easy 50-Word Test. Note the fact that no children of the 4th, 3d, or *2b* grades wholly failed in this test. In *2a*, however, 39 children were rated 10% or less, and of these there were 8 pupils who were actually marked zero. This is 4.6% of all the children of *2a*.

TABLE XXI

## DISTRIBUTION OF INDIVIDUAL RATINGS. EASY 50-WORD TEST

Table reads: in *2a* 39 children, or 22%, were rated between 0 and 10%; 32 children, or 18%, were rated between 11% and 20%, etc. In *2b* 5 children, or 3%, were rated between 11% and 20%, etc.

Per Cent Correct	2a Grade		2b Grade		3d Grade		4th Grade	
	No.	%	No.	%	No.	%	No.	%
0- 10.....	39	22	0	0	0	0	0	0
11- 20.....	32	18	5	3	1	.6	0	0
21- 30.....	37	21	9	5	4	2	0	0
31- 40.....	27	16	29	17	7	4	0	0
41- 50.....	18	10	26	15	11	7	4	1
51- 60.....	14	8	47	28	25	15	13	4
61- 70.....	5	3	31	18	33	20	29	9
71- 80.....	2	1	14	8	36	21	50	16
81- 90.....	1	.6	7	4	30	18	86	27
91-100.....	0	0	1	.6	21	13	134	42
Totals.....	175		169		168		316	
Medians.....		26.50		56.17		72.50		88.12

The medians for the grades are as follows: for *2a*, 26.50%; for *2b*, 56.17%; for 3d grade, 72.50%; and for 4th grade, 88.12%. The rapid rise of spelling ability from low second through the fourth grade is remarkable. It is much greater than the improvement during the next four years. Although the interval in time between *2a* and *2b* is but half a year, the medians suggest that the increase in ability between these grades is greater than it is between any consecutive yearly grades above the second. Further analysis will more precisely confirm this inference.

Proceeding as in the case of grades 3 to 8, we show in Table XXII the amount and per cent of overlapping of each

grade beyond the medians of the other grades, together with the corresponding linear segment in terms of the Probable Error as a unit.

TABLE XXII

AMOUNT AND PER CENT OF OVERLAPPING WITH P.E. EQUIVALENTS.  
EASY 50-WORD TEST

		2a Grade	2b Grade	3d Grade	4th Grade
2a grade.....	No.	....	17	3	0
	%	....	9.71	1.71	0
	P.E.	....	1.9254	3.1429	?
2b grade.....	No.	160	....	22	4
	%	94.67	....	13.02	2.37
	P.E.	2.3932	....	1.6690	2.9395
3d grade.....	No.	165	140	....	30
	%	98.21	83.33	....	17.86
	P.E.	3.1143	1.4341	....	1.3649
4th grade.....	No.	316	308	262	....
	%	100	97.47	82.91	....
	P.E.	?	2.8976	1.4094	....

From these results, Table XXIII is computed. The object in this table is to show how, by using all the data of Table XXII, various values of the median intervals may be obtained whose averages will be the most probably correct values. The interval between the medians of 2a and 2b is written  $M_{2a-2b}$ ; that between the medians of 2b and the 3d grade is written  $M_{2b-3}$ ; etc.

It may be remarked parenthetically that in the number 1.3771 of Table XXIII for the difference between the 3d- and 4th-grade medians, we have a striking confirmation of the substantial accuracy of our results as shown in Table XVI. The corresponding number is there given as 1.3505. That these should differ by so little when carried out upon different test material is exceedingly satisfactory.

According to Table XXIII, the 2b-grade median is approximately 1.35 P.E. below the 3d-grade median. The 2a-grade median is about 1.87 P.E. further below, or 3.22 P.E. below the 3d-grade median which we have thus far used as our origin or point of reference.

But we have not yet reached the point of zero ability. Typical

TABLE XXIII  
VALUES OF MEDIAN INTERVALS AND THEIR DERIVATION  
(2a-4TH GRADE)

$M_{2a-2b}$	$M_{2b-3}$	$M_{3-4}$
1.9254 (direct)	1.6690 (direct)	1.3649 (direct)
2.3932 (direct)	1.4341 (direct)	1.4094 (direct)
1.4739 ( $M_{2a-3} - M_{2b-3}$ )	1.2175 ( $M_{2a-3} - M_{2a-2b}$ )	1.2705 ( $M_{2b-4} - M_{2b-3}$ )
1.6802 ( $M_{3a-2} - M_{3-2b}$ )	1.5746 ( $M_{2b-4} - M_{3-4}$ )	1.4635 ( $M_{4-2b} - M_{3-2b}$ )
	.7211 ( $M_{3-2a} - M_{2b-2a}$ )	
	1.4882 ( $M_{4-2b} - M_{4-3}$ )	
Averages 1.8682	1.3518	1.3771

2a children have *some* ability, namely, according to our record, an ability to score 26.5% in the Easy 50-Word Test. The children of that grade who were unable to write any word correctly were 8 in number, representing 4.6 per cent. These 8 are included in the 39 rated between zero and 10% (Table XXI). Assuming that 2a children are grouped about their median according to the "normal" distribution, we find that in order to cut off 4.6% from the low end we must take a point 2.5 P.E. below the median, (See Table XIV). This brings the zero-point at 5.72 P.E. below the 3d-grade median (3.22 + 2.5).

This figure, 5.72 P.E., can only be taken as approximately correct. It would be somewhat influenced by an increase of the number of children tested. There is, however, no reason to suppose that the children in schools II and VIII were unusual. The testing in grades 3 to 8 in all other schools shows that results in these two schools do not materially differ from the general results. In both central tendencies and variabilities they are a fair average. There seems, then, to be no good reason why we should not consider the ratings of children in these

schools as typical. It must be borne in mind, however, that the classification of children into grades is a broad one. Just as we found it necessary to treat 2d-year children in half-yearly sections, so we should find that testing at the beginning even of a 20-week term would yield results, especially in the low grades, quite different from those obtained by testing toward the close of the term. Accordingly, the middle of the term is the best time at which to find typical conditions. Moreover, in order that the results may be comparable, the testing of all grades should be done at the same time. If 2a children were tested towards the end of their term in that grade, while 2b children were tested towards the beginning of theirs, the median interval would be unduly shortened. A considerable addition to the reliability of our results is found in the fact that all children were tested during the 10th week of a 20-week term.

We may therefore conclude that the intervals between grades 2a, 2b, 3 and 4 are substantially as found in Table XXIII. But as to the distance of the zero-point below the 2a-grade median, we cannot be precise. Four and six-tenths per cent of the 2a children got no word right. As many as 22 per cent wrote less than 6 words correctly. Some of them probably spelled these few simple words correctly by mere chance. If this were true, they would have practically no spelling ability. The situation is more complicated than the above analysis indicates. If we were to assume that *all* the children who wrote 0-5 words correctly had practically no spelling ability (written), the zero-point would then be but 1.15 P.E. below the median instead of 2.5 P.E. If we were to assume that *some* of these children—say those who wrote no more than 3 words correctly—had zero ability, we should find that 29 of the 39 in Table XXI were included. Such an assumption would place our zero-point at 1.44 below the median. There are reasons for thinking that this is not far from the true position. The best judgment, therefore, that we can make from our data and from our knowledge and experience of school conditions is, that the zero-point is about 1.5 P.E. below the 2a median, or about 4.72 P.E. below the 3d-grade median.

We may summarize our results, then, in Table XXIV and Fig. 21, as follows:

TABLE XXIV  
MEDIAN INTERVALS. ZERO TO 8TH GRADE MEDIAN

	Successive Intervals	Distance Above 0
2a grade . . . . .	1.50	1.50
2b " . . . . .	1.87	3.37
3d " . . . . .	1.35	4.72
4th " . . . . .	1.35	6.07
5th " . . . . .	.84	6.91
6th " . . . . .	1.05	7.96
7th " . . . . .	.66	8.62
8th " . . . . .	.91	9.53

Fig. 21, page 62, shows these facts graphically.

§ 15. *Observations on the Distributions Shown in Fig. 21*

It is to be remembered that in Fig. 21 the eight surfaces of frequency constructed on each median vertical are theoretical and not according to the record. Moreover, they express the assumptions that for each grade the distribution of ability in spelling is strictly "normal" and that the real variability is alike in all grades. In a later section we shall take up the matter of applying to our results distributions which are not normal. Meanwhile, however, it will be interesting to observe how satisfactory a strictly normal form of distribution proves to be. To the extent that it expresses the same or nearly the same facts as the record (so far as it should, if valid, do so), it shows its value.

1. In Fig. 21 the 2a surface of frequency does not reach the 4th-grade median; but it only falls short a little. According to the record in the Easy 50-Word Test no 2a child did as well as the median 4th grade child. But the best 2a record was 82% which is only a little less than  $M_4$  (88.12 by Table XXI).

2. In the graphic showing the 3d-grade distribution does not quite reach the 8th-grade median. Similarly the record shows that no 3d-grade child obtained a score equal to 94.68 which (Table XI, p. 27) is  $M_8$  for the Selected 100-Word List; although 3 third-grade pupils had scores in the 91 to 95 group. (Table XI, column 2.)

3. By the figure we see that the low end of the 8th-grade distribution falls short of  $M_3$  but not of  $M_4$ . In the record the

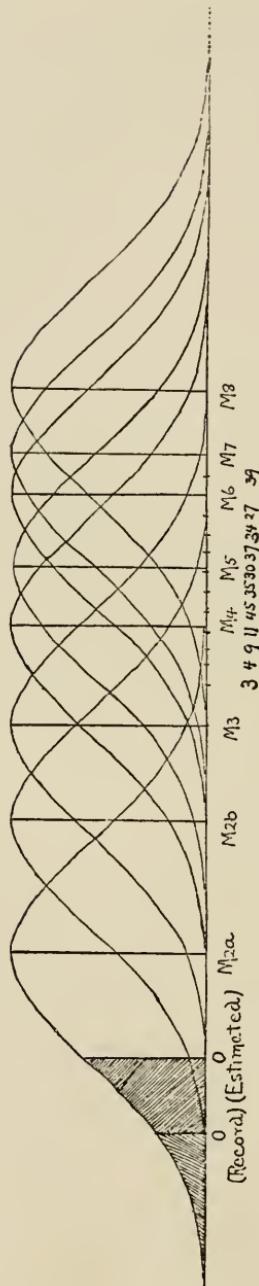


FIG. 21. Distributions (Normal) around grade medians. Entire range of spelling ability in the elementary school. The numbers 3, 4, 9, 11, 45, etc., refer to the words of the ten-point scale; they are placed so as to show the relation of this ten-point scale to the entire scale of difficulty of spelling words. 3 = only, 4 = smoke, 9 = another, 11 = pretty, 45 = answer, 35 = tailor, 30 = circus, 37 = telephone, 34 = saucy, 27 = beginning, and 39 = too.

same is true, although the poorest 8th-graders surpassed the median of the 3d grade by more than the figure would indicate (See Table XI, page 27).

4. The  $2b$  curve at its low end does not reach zero (record). No 3d-grade child was rated 0 in the Easy 50-Word Test (Table XXI, p. 57).

5. The most remarkable thing in the figure is the fact that the high end of the  $2a$ -grade distribution extends above the low end of the 8th-grade distribution. Even with all the recent information about retardation, acceleration, mental defect, and precocity combined with mis-grading and forced promotions, some critics will be hardly prepared to believe that any children classified in the first half of the second year of school life can do as well in spelling as the poorest who are classified in the 8th (last elementary) year. This, however, the figure shows; and there is good evidence in our record to support it. We cannot compare these extreme grades directly because they did not write the same test. But in Table XI (page 27) we observe that for the Selected List one 8th-grade pupil is in the 56-60 group. As a matter of fact his paper was rated at exactly 56%. Therefore all the 3d-grade children in groups above 51 to 55 did as well or better. This proves to be 22.5% of the 3d-grade children. It is remarkable that between one-quarter and one-fifth of our 3d-grade children do as well or better than the poorest 8th-grade child. But this is not all. In the Easy 50-Word Test the highest  $2a$  score was 82%. Only 38 out of 168 3d-grade children, or 22.6%, did better. See Table XXI, page 57. (The one child in group 81-90 in the  $2a$  column was rated 82. In the 3d-grade column, of the 30 in group 81-90 and the 21 in group 91-100 combined, 38 were rated above 82%.) We therefore find that the best  $2a$  child and the poorest 8th-grade child are equalled or surpassed by the *same group* of 3d-grade children,—i.e.,  $22\frac{1}{2}\%$ . Hence the best  $2a$  child and the poorest 8th-grader of our record *do* have the same ability. To show this fact, the  $2a$  curve should pass slightly beyond the low end of the 8th-grade curve, as in fact it does. This may seem to be drawing over-fine conclusions, but it is probable that the real overlapping is as great as the record shows. If, out of so few  $2a$  children (175), one was found who scored 82%,

it is likely that, with a much larger number, there would not only be more children at 82% but some at even higher rating. Similarly it is likely that if a much greater number of 8th-year children had been tested some would have obtained less than 56%. To the extent that either one or both of these probabilities were true, the overlapping would somewhat exceed that which the record suggests.

6. After the argument of the last paragraph it need hardly be said that there is both in the graphic representation by theory and in the actual record an overlapping of every grade distribution on every other from low 2d to 8th.

The location of the zero-point enables us to draw some interesting conclusions which were not possible before. A few of these will be briefly stated. Taking the medians of each grade as indicating typical abilities, regarding the *estimated* zero-point as the true one, assuming normal distributions and equal real variabilities for all grades, and defining "to spell twice as well" as "*to spell words of twice as much difficulty*," Fig. 21 shows that 2b children are more than twice as good spellers as 2a children, and that 3d-graders are about three times as capable, and 4th-graders 4 times as capable. Fifth-grade children spell twice as well as 2b children. Eighth-grade children are only twice as good as 3d-grade children. This last statement means that typical children who have reached the 3d grade have half as much spelling ability as is required of the average child in the last year of the elementary school.

We have in Fig. 21 a representation by which the entire range of difficulty of spelling words, appropriate to the elementary school, may be shown. The notation below the base-line shows the positions within that range taken by the 10 words of our scale which stand at equal intervals upon it (Table XX, page 52). Since these words include both the easiest word ("only") and the hardest ("too") of the entire scale they show its total spread. It will therefore be seen to what extent the statement is true which was made at the beginning of Section 14 to the effect that with these 50 words we have only succeeded in scaling "a limited segment of the entire projection representing spelling ability." By actual measurement it appears that this segment is but a trifle more than one-fifth of the entire

projection. It will now, however, become apparent that no greater segment *could have been so scaled* reliably from the limited material at our disposal. By reference to Fig. 21 it will be seen that no words easier than "only" could have been used and still have been clearly within the 8th-grade distribution. On the other hand no word that scales much higher than "too" could have been used and still have been clearly within the 3d-grade distribution. With, say, ten thousand children of each grade tested each with a longer list, a wider spread could have been obtained. The series of fifty words which we used spreads over nearly the whole of the base-line common to both the 3d- and 8th-grade curves.

It is evident, therefore, that much remains to be done to perfect a scale which shall pretend to completeness. Some of this further scaling will be undertaken in a later section of this monograph. A great deal must be left for later studies. A great many more words must be used both to fill in the gaps within the present scale and to extend its limits. Our main purpose has been to show the theory and technique required.

#### § 16. *Supplementary Testing at Schools VI and VII*

After the data thus far given were in hand the same test material was used in two other schools. The results of this supplementary testing are now given. The Selected List (100 words) was dictated during the fall term of 1912 at schools VI and VII to 1770 children. Two of the assistants in psychology at Teachers College acted as examiners, and the papers were then scored for individual ratings, but not for word ratings. Table XXV gives the distribution of these ratings and the grade medians for these two schools. Table XXVI gives the comparisons by grades of the combined results in schools VI and VII with those in schools II, III, IV, and V taken together. The comparison shows that in general schools VI and VII did not do so well as those tested earlier. On the average the grade medians are nearly  $6\frac{1}{2}$  per cent lower.

To one who would expect close conformity to our previous individual ratings in the case of any school taken at random, this discrepancy will be disappointing. But to one who recognizes the wide variability among schools in every subject, the

TABLE XXV  
DISTRIBUTION OF INDIVIDUAL RATINGS, SCHOOLS VI AND VII.  
SELECTED (100) LIST

Per Cent Correct	3d Grade		4th Grade		5th Grade		6th Grade		7th Grade		8th Grade	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0- 10	69	22.7	10	3.4	1	.3	3	1.2	0	0	0	0
11- 20	58	19.1	32	10.8	5	1.7	5	2.0	2	.6	0	0
21- 30	65	21.4	29	9.8	12	4.1	8	3.2	2	.6	0	0
31- 40	49	16.1	34	11.5	24	8.3	7	2.8	5	1.5	2	.7
41- 50	29	9.5	40	13.5	31	10.6	13	5.2	3	.9	1	.3
51- 60	17	5.6	51	17.6	41	14.1	23	9.2	13	3.9	3	1.0
61- 70	10	3.3	39	13.2	47	16.2	28	11.2	41	12.2	15	5.1
71- 80	6	2.0	29	9.8	53	18.3	51	20.4	56	16.6	16	5.5
81- 90	1	.3	25	8.4	58	20.0	51	20.4	114	33.8	97	33.1
91-100	0	0	7	2.4	18	6.2	61	24.4	101	30.0	159	54.3
Totals...	304		296		290		250		337		293	c.
Medians.		25.27		51.75		67.67		79.36		84.86		91.96

TABLE XXVI  
COMPARISON OF RESULTS OBTAINED IN SCHOOLS VI AND VII WITH  
THOSE OBTAINED IN SCHOOLS II, III, IV AND V

Figures show per cent of pupils in each grade who were rated 0-10, 11-20, etc.

Per Cent Correct	3d Grade		4th Grade		5th Grade		6th Grade		7th Grade		8th Grade	
	Sch. II, III, IV, V	Sch. VII, VI, V, VII										
0- 10	6.9	22.7	.4	3.4	.6	.3	0	1.2	0	0	0	0
11- 20	15.2	19.1	4.7	10.8	.6	1.7	0	2.0	0	.6	0	0
21- 30	20.5	21.4	7.7	9.8	3.5	4.1	.5	3.2	0	.6	0	0
31- 40	16.1	16.1	12.0	11.5	4.6	8.3	.5	2.8	.5	1.5	0	.7
41- 50	13.0	9.5	13.5	13.5	8.9	10.6	2.4	5.2	.8	.9	0	.3
51- 60	11.2	5.6	12.4	17.6	10.1	14.1	5.0	9.2	2.2	3.9	.4	1.0
61- 70	9.6	3.3	14.6	13.2	17.8	16.2	8.4	11.2	3.8	12.2	1.5	5.1
71- 80	4.7	2.0	17.1	9.8	21.0	18.3	19.6	20.4	13.4	16.6	6.9	5.5
81- 90	1.8	.3	12.7	8.4	19.6	20.0	30.6	20.4	32.0	33.8	21.7	33.1
91-100	.7	0	5.0	2.4	13.2	6.2	33.1	24.4	47.1	30.0	69.7	54.3
Medians...	35.80	25.27	60.70	51.75	73.10	67.67	84.90	79.36	90.50	84.86	94.68	91.96

difference will occasion no surprise. We should do well also to bear in mind not only that schools do vary greatly, but that in this particular instance there was a constant factor tending to lower the ratings. In the supplementary test the dictation was given by a stranger; in the original test by the class teacher, guided by printed directions. Leaving out of account any sugges-

tion of unfair methods on the part of teachers for the purpose of making a showing, this fact is quite sufficient to account for a falling off of results in schools VI and VII without supposing them to be much, if any, inferior to the others in the ability of their children to spell. The teacher has but one class to examine and she takes her time. She doubtless takes full advantage of the direction permitting the reading of a sentence "in whole or in part as many times as may be necessary to secure its full comprehension." She knows her class. The peculiarities or defects of pupils are her daily concern and she modifies her appeal accordingly. The children are at ease in her presence. They know her voice and manner of speaking; and they more readily understand her than they would another. In these matters they are placed at a disadvantage when examined by a stranger.

We should expect this disadvantage to be most evident in the lower classes; and an inspection of the medians of Table XXVI shows how strikingly this is true. The children of the 3d grade fell off 10.5%; of the 4th, 9%; of the 5th, 6th, and 7th approximately 5.5%; and of the 8th only 2.5%. The force, whatever its nature, tending to depress the results at schools VI and VII was clearly operative to a greater degree in the lower classes and to a much less degree in higher classes. The effect of a change from the class teacher to a stranger as examiner would be expected to bring about results of just such a nature.

But the obvious advantage of having the same examiner for every class (in this case there were two working together) is that however the results in general may be lowered, there is a better opportunity to compare class with class or grade with grade, or school with school.

The real reason why this supplementary testing was undertaken was to verify the median intervals that had been derived from the original testing. The fact of classes being examined by the same persons is of great value for this purpose. If, with this factor of the examiner made constant, we find that these median distances in spite of a falling off of grade performances remain substantially the same, we shall be justified in feeling that our former results are reasonably reliable.

TABLE XXVII

NUMBER AND PER CENT OF PUPILS IN EACH GRADE WHOSE ABILITY EQUALLED OR EXCEEDED THAT OF THE MEDIAN PUPIL IN EVERY OTHER GRADE, WITH THE P.E. VALUES CORRESPONDING TO EACH PER CENT.  
SCHOOLS VI AND VII COMBINED WITH SCHOOLS II, III,  
IV AND V

		3d Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade
3d grade...	No.		110	38	12	4	0
N=749....	%		14.7	5.1	1.6	.5	0
	P.E.		1.55	2.425	3.18	3.82	?
4th grade...	No.	619		223	90	45	16
N=763....	%	81.1		29.2	11.8	5.9	2.1
	P.E.	—1.31		.81	1.76	2.32	3.01
5th grade...	No.	758	584		227	121	47
N=805....	%	94.2	72.5		28.2	15.0	5.8
	P.E.	—2.33	—.89		.86	1.54	2.33
6th grade...	No.	655	597	511		241	112
N=668....	%	98.1	89.4	76.5		36.1	16.8
	P.E.	—3.08	—1.85	—1.07		.55	1.43
7th grade...	No.	698	678	615	482		188
N=702....	%	99.43	96.6	87.6	68.7		26.8
	P.E.	—3.75	—2.71	—1.71	—.72		.92
8th grade...	No.	570	565	544	502	428	
N=570....	%	100.0	99.12	95.44	88.1	75.1	
	P.E.	?	—3.52	—2.50	—1.75	—1.00	

In Table XXVII we give the number and per cent of pupils who equal or surpass the medians of other grades than their own with the corresponding P.E. values. In this table are combined the children who were examined at schools VI and VII with those examined at schools II, III, IV and V. It is to be compared with Table XV (page 36). Table XXVIII gives the median distances as derived from the P.E. values of Table XXVII. Compare with Table XVI (page 39). The average distances, 1.37, .87, .90, .66, and .86, are to be compared with the values for the same distances as derived on page 39, namely (correct to 2 decimal places) 1.35, .84, 1.05, .66, and .91. Only in the case of  $M_{5-6}$  is there an important difference. The average difference, including that of  $M_{5-6}$ , is .05; excluding it, the average difference is but .025. The entire range from  $M_3$  to  $M_8$  is found

to be 4.66 as compared with 4.81 according to the primary testing. These correspondences are, we feel, quite close enough to establish the essential reliability of our original figures.

TABLE XXVIII  
MEDIAN DISTANCES DERIVED FROM THE P.E. VALUES OF TABLE XXVII

	$M_{3-4}$	$M_{4-5}$	$M_{5-6}$	$M_{6-7}$	$M_{7-8}$
	1.55 (direct)	.87 ( $M_{3-5} - M_{3-4}$ )	.76 ( $M_{3-6} - M_{3-5}$ )	.64 ( $M_{3-7} - M_{3-6}$ )	? ( $M_{3-8} - M_{3-7}$ )
	1.61 ( $M_{3-5} - M_{4-5}$ )	.81 (direct)	.95 ( $M_{4-6} - M_{4-5}$ )	.56 ( $M_{4-7} - M_{4-6}$ )	.69 ( $M_{4-8} - M_{4-7}$ )
	1.42 ( $M_{3-6} - M_{4-6}$ )	.90 ( $M_{4-6} - M_{5-6}$ )	.86 (direct)	.68 ( $M_{5-7} - M_{5-6}$ )	.79 ( $M_{5-8} - M_{5-7}$ )
	1.50 ( $M_{3-7} - M_{4-7}$ )	.78 ( $M_{4-7} - M_{5-7}$ )	.99 ( $M_{5-7} - M_{6-7}$ )	.55 (direct)	.88 ( $M_{6-8} - M_{6-7}$ )
	? ( $M_{3-8} - M_{4-8}$ )	.68 ( $M_{4-8} - M_{5-8}$ )	.90 ( $M_{5-8} - M_{6-8}$ )	.51 ( $M_{6-8} - M_{7-8}$ )	.92 (direct)
	1.31 (direct)	1.02 ( $M_{5-3} - M_{4-3}$ )	.75 ( $M_{6-3} - M_{5-3}$ )	.67 ( $M_{7-3} - M_{6-3}$ )	? ( $M_{8-3} - M_{7-3}$ )
	1.44 ( $M_{5-3} - M_{5-4}$ )	.89 (direct)	.96 ( $M_{6-4} - M_{5-4}$ )	.86 ( $M_{7-4} - M_{6-4}$ )	.81 ( $M_{8-4} - M_{7-4}$ )
	1.23 ( $M_{6-3} - M_{6-4}$ )	.78 ( $M_{6-4} - M_{6-5}$ )	1.07 (direct)	.64 ( $M_{7-5} - M_{6-5}$ )	.79 ( $M_{8-5} - M_{7-5}$ )
	1.04 ( $M_{7-3} - M_{7-4}$ )	1.00 ( $M_{7-4} - M_{7-5}$ )	.99 ( $M_{7-5} - M_{7-6}$ )	.72 (direct)	1.03 ( $M_{8-6} - M_{7-6}$ )
	? ( $M_{8-3} - M_{8-4}$ )	1.02 ( $M_{8-4} - M_{8-5}$ )	.75 ( $M_{8-5} - M_{8-6}$ )	.75 ( $M_{8-6} - M_{8-7}$ )	1.00 (direct)
Average	1.37	.87	.90	.66	.86

§ 17. *Arrangement of the Words of the Preferred List by Teachers' Judgments*

A certain order of difficulty of the 50 words of the Preferred List having been determined as the result of testing in five schools and to a certain extent verified by a record from two other schools (Table XIX, and Fig. 20), a comparison of the result with an arrangement of the same words based on the judgment of teachers becomes interesting. It has an important

bearing on the whole spelling situation because it is by individual judgment as to the difficulty of words that lists are made up and graded for classes, schools, or systems of schools. How far such grading is reliable may be gathered by finding out to what extent individual judgment squares with the results of actual testing.

For this purpose the 50 words of the Preferred List were arranged alphabetically and distributed to a number of teachers. They were asked to arrange the words in what they judged to be their order of difficulty for children to spell, beginning with the easiest. They were particularly requested to do the work without consulting any one. Two hundred arrangements were secured. They differed widely—so widely that whatever may be the value of a consensus of many individuals, the trustworthiness of the judgment of a single teacher appears to be almost of no value. It may be good and it may be bad; and it is about as likely to be the one as the other. With one notable exception, the agreement with the record was closer for the easiest and hardest words than for those of medium difficulty. This might have been expected from the fact that, as shown in Fig. 20, the words at the ends of the scale differ by larger amounts than do those nearer the middle. The exception referred to is the word "too," which, although it was in every school the hardest word to spell, was by more than a fourth of the teachers judged to be actually the easiest, or next to the easiest, in the list. The deviation of individual judgments from the record is shown by figures taken from a random sampling of the two hundred teachers' arrangements. Five such arrangements being taken by chance from the whole number, proved to be those of teachers No. 7, No. 88, No. 109, No. 134, and No. 178. They ranked the 5th, 10th, 15th, 20th, . . . . 50th words (record) as follows:

<i>Record</i>	5, 10, 15, 20, 25, 30, 35, 40, 45, 50	
No. 7	22, 15, 1, 31, 34, 33, 38, 47, 14, 10	$r = +0.09$
No. 88	15, 9, 4, 41, 13, 24, 33, 35, 20, 1	$r = +0.15$
No. 109	9, 11, 18, 39, 35, 36, 22, 25, 29, 10	$r = +0.15$
No. 134	24, 22, 23, 20, 6, 44, 7, 42, 35, 11	$r = -0.03$
No. 178	21, 2, 7, 22, 14, 29, 49, 38, 28, 1	$r = +0.2$

It is, however, to be expected that when a large number of judgments are taken together, wide disagreements with a true arrangement will tend to disappear, and a resultant will be obtained that may be expected to be closer to the facts than any single judgment would ever be likely to be. The statistical treatment of the 200 judgments was based on the theorem, "Differences that are equally often noticed are equal, unless the differences are either always or never noticed." It is an abbreviation of the method used by Professor Thorndike in deriving his scale for Handwriting and by Dr. Hillegas in his similar work for English Composition. We have not felt the necessity of making comparisons of the judgment of each word with that of every other word, because the nature of our material has enabled us to derive our scale by a more direct method. Since we are here concerned with a comparison only, we have been content to proceed as follows: The record shows "only" to be easier than "even." What per cent of the individuals who arranged the words for difficulty so judged? As between "even" and "smoke"; "smoke" and "chicken"; "chicken" and "front"; etc., what per cent of the judgments indicate that the first word of each pair is easier than the second, as the record shows? The following is found to be true for the first six words:

"only"	was judged easier than	"even"	by 38.5%	of the judges.
"even"	"	"smoke"	67.5%	" "
"smoke"	"	"chicken"	72.0%	" "
"chicken"	"	"front"	48.0%	" "
"front"	"	"another"	53.0%	" "

Now when the difficulty of a word is judged by a very great number of judges some will overestimate its difficulty, others will underestimate it. Those who make small errors will be more numerous than those who make large errors. The frequency of the judgments will take the form of the curve of the probability integral whose base-line represents the amounts of difficulty which the word in question is judged to have. The point on the base-line which corresponds to the greatest frequency of judgments represents the central tendency of the judges in rating the word. It is therefore the point which represents the difficulty of the word as determined by individual judgments. Two or more words may be compared for difficulty if we know the per

cent of judges who rate one word easier (or harder) than the other.

Fig. 22 shows the curves for the first six words arranged to show the per cent of "easier" judgments noted above. The curve for "even" is so placed that 38.5% of its area is to the right of  $YO$ —the median axis of the curve for "only" when that

TABLE XXIX  
COMPARISON OF RESULTS BY TEACHERS' JUDGMENTS AND BY THE  
RECORD. PREFERRED LIST

Word- Num- ber (scale)	Word	% of times each word was judged easier than the following word	Rank		Word- Num- ber (scale)	Word	% of times each word was judged easier than the following word	Rank	
			By Teach- ers' Judg- ments	By the Re- cord				By Teach- ers' Judg- ments	By the Re- cord
3	only....	38.5	2	1	14	minute....	25.5	27	26
1	even....	67.5	1	2	7	pear....	51.0	15	27
4	smoke....	72.0	3	3	40	towel....	69.0	16	28
28	chicken....	48.0	7	4	38	tobacco....	56.0	25.5	29
5	front....	53.0	6	5	43	whole....	15.5	28	30
9	another....	39.5	8	6	13	button....	79.5	9	31
2	lesson....	86.0	4	7	17	janitor....	81.0	23	32
8	bought....	29.5	18	8	33	quarrel....	39.5	44	33
11	pretty....	27.5	10	9	44	against....	43.5	40	34
16	nails....	89.0	11	10	30	circus....	77.0	35	35
46	butcher....	65.5	19	11	20	sword....	44.5	48	36.
41	Tuesday....	19.5	29	12	23	whistle....	21.5	46	36.5
6	sure....	74.5	13	13	19	stopping....	87.0	30	38
45	answer....	10.0	21.5	14	24	carriage....	29.0	49	39
25	nor....	90.0	5	15.5	47	guess....	54.0	43	40
49	raise....	69.0	21.5	15.5	37	telephone....	27.0	45	41
15	cousin....	53.0	37	17.5	29	choose....	56.0	31	42
50	beautiful....	41.5	39	17.5	36	telegram....	54.5	36	43
22	touch....	29.5	33	19	18	saucer....	58.0	38	44
21	freeze....	31.5	20	20	34	saucy....	35.5	41	45
10	forty....	75.0	12	21.5	26	already....	91.5	34	46
48	instead....	33.0	24	21.5	32	pigeons....	16.0	50	47
12	wear....	44.0	17	23	27	beginning....	64.0	42	48
35	tailor....	72.5	14	24.5	31	grease....	21.0	47	49
42	tying....	55.0	25.5	24.5	39	too....	....	32	50

axis is produced; 67.5% of the curve for "smoke" is to the right of  $Y^1O^1$  produced; 72% of the curve for "chicken" is to the right of  $Y^2O^2$  produced; and so on.  $HO^1$  is the difference in difficulty between "only" and "even";  $KO^2$ , between "even" and "smoke";  $PO^3$ , between "smoke" and "chicken";  $SO^4$ , between "chicken" and "front"; and  $TO^5$ , between "front" and "another." When less than 50% of the judges regard the first of a pair of words as easier, the second is, of

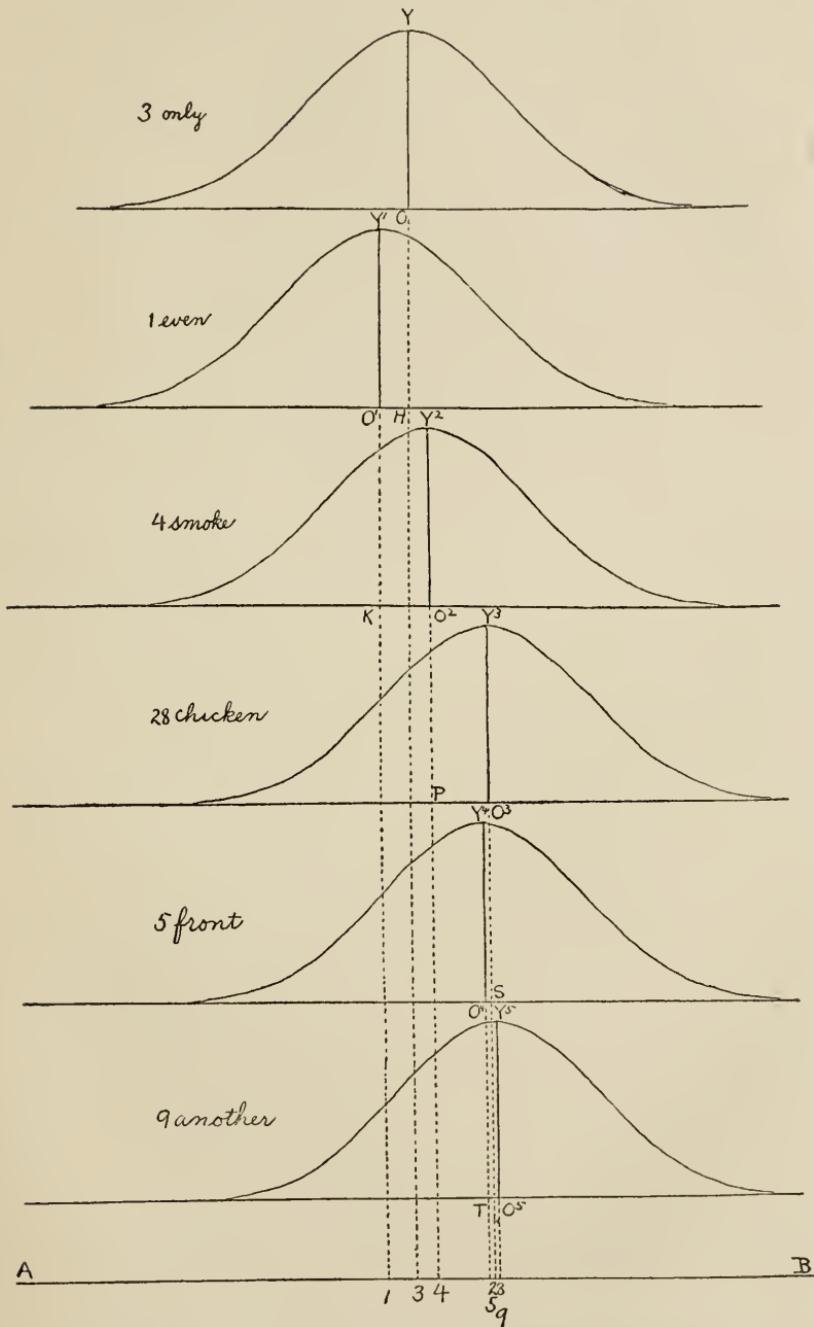


FIG. 22. Diagram showing difference in difficulty between words by Teachers' Judgments.

course, judged the easier, and the difference in difficulty is a negative one. Such is the case in the *only-even* and *chicken-front* pairs. The scaling of these six words is diagrammatically shown in Fig. 22 by producing each median vertical to meet the line *AB*. It will be seen that the order of difficulty is not the same as the order obtained by testing.

Table XXIX shows for the entire 50 words the per cent of teachers who judged each word easier than the following word and the rank of each word for difficulty by record and by teachers' judgments. In spite of the fact that the opinion of single teachers is so unreliable, the combined judgments of a group as large as 200 yield an arrangement which agrees closely enough with the arrangement by record to confirm and support the latter in no small degree. The correlation, by the 'foot-rule' method, is found to be 0.79, which may quite properly be regarded as satisfactory.

It may be worth while to point out, however, that in practice the selection and arrangement of words for teaching are not the work of a large number of individuals. These things are usually done by a single teacher for a class or by a text-book writer for as many classes as use his book. Not two hundred, probably not even ten, persons judge as to the selection and arrangement of the words in the lists now used in most schools. The length of such lists, moreover, would seem to preclude the possibility of a satisfactory judgment as to difficulty by individuals. Probably if our own list of 50 words had been shorter, the teachers would have worked more accurately. The several thousand words in a spelling-book certainly constitute a list about which there may be expected to be wide and numerous disagreements. We alluded in Section 3 above to our attempt to secure for school use a 5000-word vocabulary graded by years and based upon the agreements of five spelling-books. This task proved to be very difficult precisely because of the total absence of agreement as to grading in the case of hundreds of words. One speller would assign words to the third grade which another would put in the sixth, seventh, or eighth. Gradings three, four, and even five years apart occurred with remarkable frequency.

The obvious way (and the necessary way, it would seem) to grade words for difficulty is not by some one's opinion of how

hard they are, but by actually "trying them out." In matters of handwriting and composition the judgment of individuals is all-important, because merit in either is precisely a matter of judgment. One sample is better than another only because competent persons think so. On the contrary, one word is harder to spell than another not because we think so, but because more people misspell the one than the other, or because it takes more time to learn to spell the one than the other. It is strange, therefore, that no spelling-book has yet appeared based upon a study of how frequently children misspell the words of which it is composed. In fact no study of spelling, that we know of, has done more than obtain individual ratings of pupils, based on the tacit assumption that the words used are all equally difficult to spell. No investigation has been thought necessary of the words themselves. The results of this section, although by no means thoroughly worked out, sufficiently indicate the present unreliability of individual judgment with regard to words, unless the list is very short and the judgments very numerous. It is quite possible that at some later time, after studies of words based on actual tests have been frequently made, our judgment of word difficulties may be greatly improved. Our opinion as to how hard words are might then become a valuable supplement to the conclusions of the investigator.

#### § 18. *Rice Sentence Test. Easy 50-Word Test*

During the middle week of the fall term of 1912, the sentence test used by Rice—and afterwards by Cornman—was dictated to 1984 pupils in schools II, III, and VIII. Children of the 4th and 5th grades wrote sentences containing 50 words; those of the 6th, 7th, and 8th grades wrote 41 of the same words together with 36 additional words—77 in all. The entire test follows:

#### *Rice Sentence Test*

*While running he slipped. I listened to his queer speech, but I did not believe any of it. The weather is changeable. His loud whistling frightened me. He is always changing his mind. His*

chain was *loose*. She was *baking* cake. I have a *piece* of it. Did you *receive* my letter? I heard the *laughter* in the *distance*. Why did you *choose* that *strange picture*? \*Because I thought I liked it. It is my *purpose* to *learn*. Did you *lose* your *almanac*? I gave it to my *neighbor*. \*I was *writing* in my *language book*. Some children are not *careful enough*. Was it *necessary* to keep me *waiting* so long? Do not *disappoint* me so *often*. I have *covered* the *mixture*. He is *getting better*. \*A *feather* is *light*. Do not *deceive* me. I am *driving* a new horse. \*Is the *surface* of your *desk* *rough* or *smooth*? The children were *hopping*. This is *certainly* true. I was very *grateful* for my *elegant present*. If we have *patience* we will *succeed*. He met with a *severe accident*. Sometimes children are not *sensible*. You had no *business* to *answer* him. You are not *sweeping* *properly*. Your *reading* shows *improvement*. The *ride* was very *fatiguing*. I am very *anxious* to hear the *news*. I *appreciate* your *kindness* I *assure* you. I cannot *imagine* a more *peculiar character*. I *guarantee* the *book* will meet with your *approval*. *Intelligent* persons learn by *experience*. The *peach* is *delicious*. I *realize* the *importance* of the *occasion*. Every rule has *exceptions*. He is *thoroughly conscientious*; therefore I do trust him. The *elevator* is *ascending*. Too much *praise* is not *wholesome*.

TABLE XXX  
DISTRIBUTION OF INDIVIDUAL RATINGS. RICE SENTENCE TEST.

Per Cent Correct	4th Grade		5th Grade		6th Grade		7th Grade		8th Grade	
	No.	%								
0- 10.....	38	7.5	3	.6	2	.5	0	0	0	0
11- 20.....	54	10.7	13	2.8	13	3.3	3	.8	0	0
21- 30.....	61	12.0	18	3.8	21	5.3	5	1.4	0	0
31- 40.....	55	10.8	49	10.4	46	11.6	20	5.4	0	0
41- 50.....	72	14.2	62	13.2	53	13.4	32	8.7	2	.8
51- 60.....	74	14.6	76	16.2	80	20.2	52	14.2	15	6.1
61- 70.....	59	11.6	76	16.2	70	17.7	53	14.4	37	15.2
71- 80.....	54	10.7	91	19.4	62	15.7	77	21.0	61	25.0
81- 90.....	31	6.1	65	13.8	40	10.1	95	25.9	96	39.3
91-100.....	9	1.8	17	3.6	9	2.3	30	8.2	33	13.5
Totals.....	507		470		396		367		244	
Medians.....		48.17		64.13		58.57		73.86		82.07

The 4th- and 5th-year test ends with "This is *certainly* true." The test for the upper grades comprises all the sentences except the four marked with an asterisk. The test words are italicized.

The principal object in giving this test was to obtain scores for a new series of words by which the grade and general scales (Figs. 14-20) could be supplemented and extended. The papers, however, were also rated for individual performances. Subject

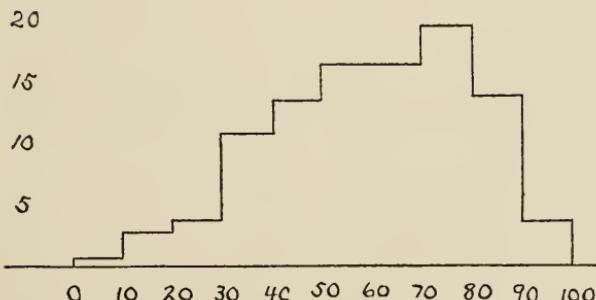
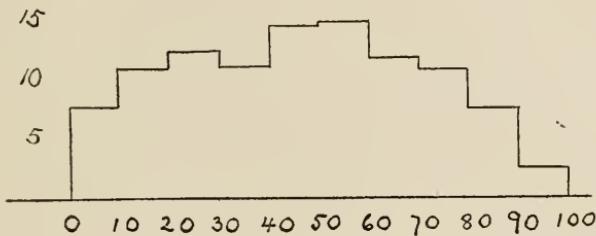


FIG. 23. Relative frequencies of different percentages correct, 4th grade;

Rice Sentence Test; Table XXX.

FIG. 24. Same as Fig. 23, but for 5th grade.

to the limitations of regarding all words as equal, the results on this basis may be used to supplement those of Rice and Cornman. Rice gives nothing but grade averages, and Cornman gives the same for two tests after an interval of one year. We shall continue to use the median as a measure of central tendency and shall give a distribution of pupils' ratings for each grade. Table XXX gives the distribution by groups of ten with totals and medians. Fig. 23 and Fig. 24 show graphically the distribution

for the 4th and 5th grades. Fig. 8, Fig. 9, and Fig. 10 (page 33) give the same for 6th, 7th, and 8th grades.

These medians indicate a performance for these schools poorer than Rice indicates for most of his schools and much poorer than Cornman's results for the two schools which he tested. We cannot account for this because neither of these investigators tells how he rated the pupils' papers. In our own testing omitted and illegible words were counted as wrong. It is probable that the manner in which Rice chose his schools would give him those in which better than average work was being done; while Cornman's two schools were without doubt devoting an unusual amount of attention to spelling under his personal guidance. Such being the case, it is quite possible that the results here given more nearly approach typical conditions, than do those of either of these writers.

TABLE XXXI  
PER CENT CORRECT FOR EACH WORD IN EACH GRADE WITH CORRESPONDING P.E. VALUES. RICE SENTENCE TEST. SEE FIG. 25

No. of Word	Word	4th Grade		5th Grade		6th Grade		7th Grade		8th Grade	
		%	P.E.								
1	running....	48.0	+.074	66.0	—	.612	76.8	—1.086	85.0	—1.537	93.4
2	slipped....	30.0	+.777	34.8	+	.579	42.9	+.265	51.8	—.067	70.9
3	listened....	29.6	+.794	40.4	+	.360	53.5	—.130	69.8	—.769	86.9
4	queer....	56.9	—.258	58.8	—	.330	77.3	—1.110	79.0	—1.196	87.3
5	speech....	45.3	+.175	41.4	+	.322	72.0	—.864	77.1	—1.101	80.7
6	believe....	37.2	+.484	49.7	+	.011	64.4	—.547	62.1	—.457	76.6
7	weather....	70.9	—.816	57.5	—	.280	82.8	—1.403	88.0	—1.742	92.2
8	changeable....	27.7	+.878	31.3	+	.723	46.7	+.123	66.8	—.604	65.6
9	whistling....	27.3	+.895	40.0	+	.376	49.0	+.037	68.7	—.723	74.2
10	frightened....	17.8	+.1368	42.7	+	.273	55.6	—.209	71.4	—.838	85.7
11	always....	53.8	—.141	68.8	—	.727	78.5	—1.170	88.6	—1.788	95.5
12	changing....	58.5	—.318	69.2	—	.744	74.5	—.974	89.6	—1.867	91.4
13	chain....	51.8	—.067	59.8	—	.363	75.3	—1.014	88.0	—1.742	95.9
14	loose....	24.7	+.1014	49.1	+	.033	45.2	+.179	63.2	—.500	81.6
15	baking....	63.4	—.508	75.7	—1.033	83.6	—1.450	93.5	—2.245	97.5	—2.905
16	piece....	58.5	—.318	62.2	—	.461	69.9	—.773	83.7	—1.456	90.6
17	receive....	21.1	+.191	51.7	—	.063	59.8	—.368	62.1	—.457	80.7
18	laughter....	59.9	—.372	71.4	—	.833	75.5	—1.024	88.8	—1.803	96.3
19	distance....	35.6	+.547	67.2	—	.660	75.8	—1.038	88.0	—1.742	97.5
20	choose....	41.7	+.311	46.3	+	.138	56.8	—.254	83.1	—1.421	85.7
21	strange....	57.7	—.288	74.2	—	.963	86.9	—1.663	93.5	—2.245	92.6
22	picture....	69.6	—.761	87.5	—1.706	94.4	—2.357	97.5	—2.905	98.8	—3.346
23	because....	66.2	—.620	83.9	—1.459	—	—	—	—	—	—
24	thought....	58.7	—.326	72.4	—	.882	—	—	—	—	—
25	purpose....	21.7	+.160	47.3	+	.100	66.9	—.648	74.7	—.986	92.6
26	learn....	70.6	—.803	84.9	—1.531	93.2	—2.211	95.9	—2.579	99.6	—3.938
27	lose....	46.4	—.134	53.1	—	.119	56.8	—.254	60.0	—.376	55.7
28	almanac....	10.1	+.892	21.5	+	.1170	38.6	—.430	58.6	—.322	72.1
29	neighbor....	27.5	—.886	66.6	—	.636	65.2	—.579	85.0	—1.537	93.4
30	writing....	56.3	—.235	74.0	—	.954	—	—	—	—	—

TABLE XXXI  
(Continued)

No. of Word	Word	4th Grade		5th Grade		6th Grade		7th Grade		8th Grade	
		%	P.E.								
31	language	40.3	+.364	62.8	-.484						
32	careful	54.3	-.160	58.6	-.322	68.9	-.731	85.8	-.1.589	88.1	-.1.749
33	enough	54.9	-.183	68.0	-.693	80.3	-.1.264	91.0	-.1.988	98.4	-.3.182
34	necessary	4.5	+.2.514	21.5	+.1.170	42.7	+.2.73	37.6	+.468	61.5	-.434
35	waiting	55.9	-.220	66.8	-.604	82.3	-.1.374	89.9	-.1.892	92.2	-.2.103
36	disappoint	11.7	+.1.757	27.4	+.891	34.6	+.588	32.4	+.657	38.9	+.418
37	often	51.6	-.059	57.5	-.280	75.8	-.1.038	87.2	-.1.685	92.2	-.2.103
38	covered	42.1	+.296	62.6	-.476	77.5	-.1.120	90.2	-.1.918	97.1	-.2.811
39	mixture	33.6	+.628	62.6	-.476	83.3	-.1.432	91.0	-.1.988	97.1	-.2.811
40	getting	57.5	-.280	74.4	-.972	87.4	-.1.699	94.6	-.2.384	97.5	-.2.905
41	better	80.6	-.1.279	91.8	-.2.064	94.9	-.2.425	98.6	-.3.258	100.0	?
42	feather	77.1	-.1.101	84.1	-.1.481						
43	light	77.5	-.1.120	90.5	-.1.944						
44	deceive	18.4	+.1.335	46.3	+.138	53.5	-.1.30	54.8	-.1.179	79.5	-.1.222
45	driving	59.7	-.364	77.1	-.1.101	88.1	-.1.749	65.7	-.2.177	98.8	-.3.346
46	surface	48.4	+.059	79.1	-.1.201						
47	rough	64.2	-.539	69.8	-.769						
48	smooth	47.2	+.104	51.3	-.048						
49	hopping	58.1	-.303	58.1	-.303	68.4	-.710	81.2	-.1.313	89.3	-.1.843
50	certainly	16.8	+.1.427	36.0	+.531	57.1	-.265	79.0	-.1.196	91.0	-.1.988
51	grateful					39.1	+.410	58.6	-.322	61.9	-.449
52	elegant					53.5	-.130	65.7	-.600	69.3	-.748
53	present					69.7	-.765	79.0	-.1.196	91.4	-.2.035
54	patience					43.4	+.246	63.0	-.492	80.7	-.1.286
55	succeed					53.0	-.112	70.8	-.812	80.7	-.1.286
56	severe					40.9	+.341	61.3	-.426	70.9	-.816
57	accident					45.5	+.168	68.9	-.731	85.2	-.1.549
58	sometimes					52.5	-.093	67.3	-.665	82.8	-.1.403
59	sensible					34.3	+.600	55.0	-.187	65.2	-.579
60	business					46.0	+.149	53.7	-.138	68.4	-.710
61	answer					74.0	-.954	86.9	-.1.663	93.4	-.2.234
62	sweeping					87.4	-.1.699	92.1	-.2.093	94.7	-.2.397
63	properly					61.1	-.418	73.0	-.909	86.5	-.1.636
64	improvement					59.6	-.360	69.5	-.756	86.5	-.1.636
65	fatiguing					12.6	+.1.699	25.3	+.986	31.1	+.731
66	anxious					49.0	+.037	66.2	-.620	84.0	-.1.475
67	appreciate					31.8	+.702	49.0	+.037	74.6	-.982
68	assure					58.1	-.303	68.9	-.731	86.1	-.1.609
69	imagine					33.6	+.628	47.7	+.085	66.4	-.628
70	peculiar					24.0	+.1.047	46.3	+.138	56.1	-.228
71	character					40.2	+.368	47.1	+.108	78.7	-.1.181
72	guarantee					11.6	+.1.772	19.9	+.1.253	25.8	+.963
73	approval					38.1	+.449	56.9	-.1.258	75.4	-.1.019
74	intelligent					37.1	+.448	43.6	+.239	50.4	-.015
75	experience					44.4	+.209	63.5	-.512	68.9	-.731
76	delicious					31.3	+.723	61.6	-.437	85.2	-.1.549
77	realize					53.5	-.130	65.7	-.600	73.4	-.927
78	importance					47.5	+.093	73.3	-.922	81.6	-.1.335
79	occasion					34.8	+.579	44.4	+.209	49.6	+.015
80	exceptions					48.2	+.067	57.2	-.269	76.2	-.1.057
81	thoroughly					18.7	+.1.318	31.1	+.731	53.3	-.123
82	conscientious					.3	+.4.167	1.6	+.3.171	19.7	+.2.264
83	therefore					36.4	+.516	62.4	-.468	79.9	-.1.243
84	ascending					37.6	+.468	52.0	-.074	55.7	-.213
85	praise					69.0	-.735	78.2	-.1.155	95.9	-.2.579
86	wholesome					56.3	-.235	74.7	-.986	86.1	-.1.609

With respect to the ratings of words, Table XXXI gives for each grade the per cent of correct spellings and the P.E. values calculated from the grade medians, assuming a normal distribution. Fig. 25 (insert) shows the lines the same words arranged on a linear scale for grades 4, 5, 6, 7, and 8. Above the lines the arrangement of the words of the Preferred List is given. This latter is a repetition of the scales of Figures 15, 16, 17, 18 and 19 (p. 44). It will at once be seen that the former scales, obtained by using the Preferred List, have been filled in and have been extended much further to the right.

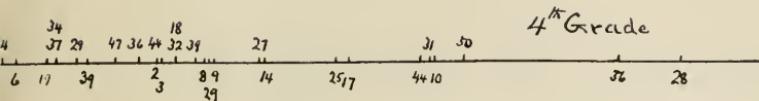
Just as the more difficult words of the Rice Test may be used to extend the scales to the right, so the easier words of the Easy 50-Word Test may be used to extend it towards the left in certain grades. In the grades of the second school year the latter were the only words used. Although the primary object in giving the Easy 50-Word Test was to enable us to give a position to the zero-point, and although for this purpose the ratings of individual pupils were sufficient, nevertheless the per cent of correct spellings for each word in each grade (*2a*, *2b*, *3d*, and *4th*) was also calculated.

Table XXXII gives these per cents and the corresponding P.E. values. It will be noted that there are six words (*even*, *only*, *pretty*, *sure*, *touch*, and *front*) that are common to this list and to the Preferred List.

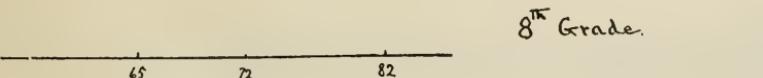
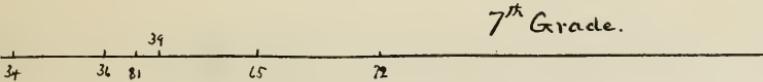
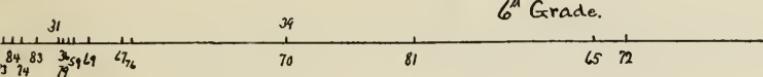
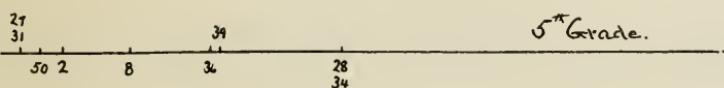
TABLE XXXII  
PER CENT CORRECT FOR EACH WORD IN EACH GRADE WITH CORRESPONDING P.E. VALUES. EASY 50-WORD TEST

No. of Word	Word	2a Grade 175 Pupils		2b Grade 169 Pupils		3d Grade 168 Pupils		4th Grade 316 Pupils	
		%	P.E.	%	P.E.	%	P.E.	%	P.E.
1	you.....	52.6	.097	71.6	.847	83.9	—1.459	93.4	—2.234
2	will.....	46.9	+.119	83.4	—1.438	96.4	—2.667	99.1	—3.506
3	hear.....	37.1	+.489	53.3	—.123	60.1	—.380	79.4	—1.217
4	him.....	25.7	+.968	71.6	—.847	81.0	—1.302	97.5	—2.905
5	coming...	9.7	+1.926	33.7	+.624	57.1	—.265	83.5	—1.444
6	he.....	62.3	.464	88.7	—1.795	98.2	—3.111	99.7	—4.083
7	is.....	65.7	.600	94.7	—2.397	96.4	—2.667	98.4	—3.182
8	on.....	57.7	.288	88.7	—1.795	94.6	—2.384	97.8	—2.986
9	the.....	65.7	.600	94.7	—2.397	94.6	—2.384	97.8	—2.986
10	road....	4.6	+2.498	20.7	+1.211	53.6	—.134	82.6	—1.391

+ 60    + 80    + 100    + 120    + 140    + 160    + 180    + 200



Word List



Easy 50-Word List, Table XXXII. These scales are not absolutely  
of the Rice List at +317. For the lists referred to see Appendix II.

-380 -360 -340 -320 -300 -280 -260 -240 -220 -200 -180 -160 -140 -120 -100 -80 -60 -40 -20 0 +20 +40 +60 +80 +100 +120 +140 +160 +180 +200

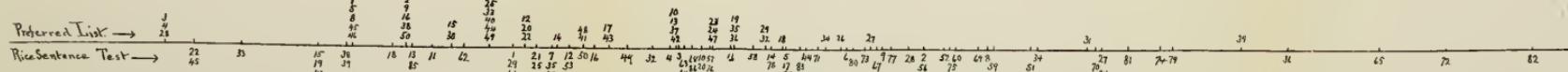
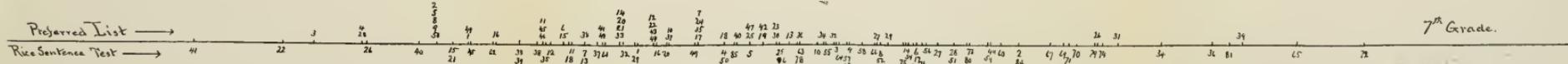
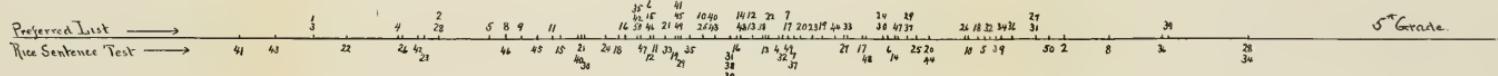
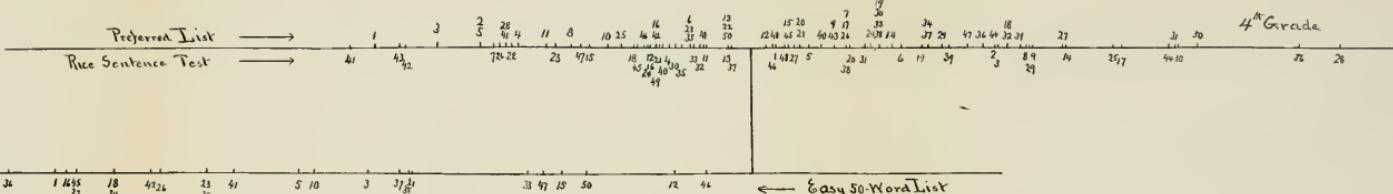


FIG. 25. Completed Grade Scale. Grades 4 to 8. Combining the Rice Sentence List, Table XXXI, with the Preferred List, Table XVII, to which is also added, for the 4th grade, the Easy 50-Word List, Table XXXII. These scales are not absolutely complete. The 4th grade scale should have word No. 34 of the Rice List at +255; the 6th grade scale should have word 82 of the Rice List at +415; the 7th grade scale should have 82 of the Rice List at +317. For the lists referred to see Appendix II.

TABLE XXXII  
(Continued)

No. of Word	Word	2a Grade 175 Pupils		2b Grade 169 Pupils		3d Grade 168 Pupils		4th Grade 316 Pupils	
		%	P.E.	%	P.E.	%	P.E.	%	P.E.
11	and.....	51.4	— .052	85.2	— 1.549	97.0	— 2.789	98.4	— 3.182
12	almost....	.6	+ 3.725	6.5	+ 2.245	42.9	+ .265	56.3	— .235
13	sure.....	1.1	+ 3.392	5.9	+ 2.321	48.8	+ .044	61.1	— .418
14	to.....	48.0	+ .074	78.7	— 1.181	93.5	— 2.245	94.9	— 2.425
15	pass.....	1.1	+ 3.392	27.8	+ .873	51.2	— .044	65.8	— .603
16	in.....	45.7	+ .160	91.1	— 1.997	92.9	— 2.177	93.0	— 2.188
17	front....	12.0	+ 1.742	27.8	+ .873	48.2	+ .067	67.1	— .656
18	of.....	25.7	+ .968	64.5	— .551	82.1	— 1.363	91.5	— 2.035
19	me.....	54.3	— 160	84.6	— 1.512	88.7	— 1.795	95.9	— 2.579
20	I.....	45.1	+ .183	93.5	— 2.245	95.2	— 2.468	100.0	?
21	send....	22.3	+ 1.130	25.4	+ .982	48.2	+ .067	76.6	— 1.076
22	for.....	34.3	+ .600	78.7	— 1.181	93.5	— 2.245	96.8	— 2.746
23	every....	3.4	+ 2.706	39.6	+ .391	66.7	— .640	88.0	— 1.742
24	day.....	36.6	+ .508	89.3	— 1.843	94.0	— 2.305	100.0	?
25	go.....	45.1	+ .183	87.0	— 1.670	89.3	— 1.843	98.1	— 3.077
26	into.....	34.3	+ .600	71.0	— .820	76.2	— 1.057	89.9	— 1.892
27	school....	16.0	+ 1.475	60.4	— .371	81.5	— 1.329	92.7	— 2.155
28	but.....	13.1	+ 2.767	58.0	— .299	83.3	— 1.432	98.4	— 3.182
29	do.....	40.1	+ .372	74.0	— .954	85.1	— 1.543	97.2	— 2.155
30	not.....	33.7	+ .624	69.2	— .744	86.9	— 1.663	96.8	— 2.746
31	touch....	.6	+ 3.725	4.7	+ 2.483	29.8	+ .786	54.4	— .164
32	table....	1.7	+ 3.146	13.0	+ 1.670	53.6	— .239	94.3	— 2.344
33	also.....	2.9	+ 2.811	15.4	+ 1.512	35.7	+ .543	68.4	— .710
34	has.....	36.0	+ .531	65.1	— .575	69.6	— .761	91.5	— 2.035
35	only....	5.7	+ 2.344	16.6	+ 1.438	53.0	— .112	70.6	— .803
36	one.....	34.9	+ .575	71.0	— .820	82.1	— 1.363	94.6	— 2.384
37	pair....	2.9	+ 2.811	11.2	+ 1.803	42.9	+ .265	77.5	— 1.120
38	shoes....	1.7	+ 3.146	18.9	+ 1.307	46.4	+ .134	76.9	— 1.091
39	they....	16.6	+ 1.438	34.3	+ .600	64.3	— .543	88.0	— 1.742
40	are.....	18.3	+ 1.340	58.0	— .299	84.5	— 1.506	95.9	— 2.579
41	at.....	43.4	+ .246	72.8	— .900	75.0	— 1.000	86.7	— 1.649
42	all.....	36.6	+ .508	62.1	— .457	73.2	— .918	90.2	— 1.918
43	pretty....	2.9	+ 2.811	20.1	+ 1.243	43.5	+ .243	78.5	— 1.170
44	no.....	23.4	+ 1.076	71.0	— .820	85.1	— 1.543	96.5	— 2.686
45	man.....	50.9	— .033	74.0	— .954	79.8	— 1.238	97.2	— 2.155
46	ought....	1.1	+ 3.392	12.4	+ 1.713	20.8	+ 1.206	53.8	— .141
47	steal....	1.7	+ 3.146	12.4	+ 1.713	29.8	+ .786	67.1	— .656
48	even....	5.1	+ 2.425	24.3	+ 1.033	48.8	+ .044	67.4	— .669
49	a.....	60.6	— .399	72.8	— .900	86.3	— 1.622	98.4	— 3.182
50	penny...	3.4	+ 2.706	13.6	+ 1.629	35.7	+ .543	63.6	— .516



TABLE XXXII  
(Continued)

No. of Word	Word	2a Grade 175 Pupils		2b Grade 169 Pupils		3d Grade 168 Pupils		4th Grade 316 Pupils	
		%	P.E.	%	P.E.	%	P.E.	%	P.E.
11	and.....	51.4	-.052	85.2	-1.549	97.0	-2.789	98.4	-3.182
12	almost....	.6	+3.725	6.5	+2.245	42.9	+.265	56.3	-.235
13	sure.....	1.1	+3.392	5.9	+2.321	48.8	+.044	61.1	-.418
14	to.....	48.0	+.074	78.7	-1.181	93.5	-2.245	94.9	-2.425
15	pass.....	1.1	+3.392	27.8	+.873	51.2	-.044	65.8	-.603
16	in.....	45.7	+.160	91.1	-1.997	92.9	-2.177	93.0	-2.188
17	front....	12.0	+1.742	27.8	+.873	48.2	+.067	67.1	-.656
18	of.....	25.7	+.968	64.5	-.551	82.1	-1.363	91.5	-2.035
19	me.....	54.3	-.160	84.6	-1.512	88.7	-1.795	95.9	-2.579
20	I.....	45.1	+.183	93.5	-2.245	95.2	-2.468	100.0	?
21	send....	22.3	+1.130	25.4	+.982	48.2	+.067	76.6	-1.076
22	for.....	34.3	+.600	78.7	-1.181	93.5	-2.245	96.8	-2.746
23	every....	3.4	+2.706	39.6	+.391	66.7	-.640	88.0	-1.742
24	day.....	36.6	+.508	89.3	-1.843	94.0	-2.305	100.0	?
25	go.....	45.1	+.183	87.0	-1.670	89.3	-1.843	98.1	-3.077
26	into.....	34.3	+.600	71.0	-.820	76.2	-1.057	89.9	-1.892
27	school....	16.0	+1.475	60.4	-.371	81.5	-1.329	92.7	-2.155
28	but.....	13.1	+2.767	58.0	-.299	83.3	-1.432	98.4	-3.182
29	do.....	40.1	+.372	74.0	-.954	85.1	-1.543	97.2	-2.155
30	not.....	33.7	+.624	69.2	-.744	86.9	-1.663	96.8	-2.746
31	touch....	.6	+3.725	4.7	+2.483	29.8	+.786	54.4	-.164
32	table....	1.7	+3.146	13.0	+1.670	53.6	-.239	94.3	-2.344
33	also.....	2.9	+2.811	15.4	+1.512	35.7	+.543	68.4	-.710
34	has.....	36.0	+.531	65.1	-.575	69.6	-.761	91.5	-2.035
35	only....	5.7	+2.344	16.6	+1.438	53.0	-.112	70.6	-.803
36	one.....	34.9	+.575	71.0	-.820	82.1	-1.363	94.6	-2.384
37	pair....	2.9	+2.811	11.2	+1.803	42.9	+.265	77.5	-1.120
38	shoes....	1.7	+3.146	18.9	+1.307	46.4	+.134	76.9	-.091
39	they....	16.6	+1.438	34.3	+.600	64.3	-.543	88.0	-1.742
40	are.....	18.3	+1.340	58.0	-.299	84.5	-1.506	95.9	-2.579
41	at.....	43.4	+.246	72.8	-.900	75.0	-1.000	86.7	-1.649
42	all.....	36.6	+.508	62.1	-.457	73.2	-.918	90.2	-1.918
43	pretty....	2.9	+2.811	20.1	+1.243	48.5	+.243	78.5	-1.170
44	no.....	23.4	+1.076	71.0	-.820	85.1	-1.543	96.5	-2.686
45	man....	50.9	-.033	74.0	-.954	79.8	-1.238	97.2	-2.155
46	ought....	1.1	+3.392	12.4	+1.713	20.8	+1.206	53.8	-.141
47	steal....	1.7	+3.146	12.4	+1.713	29.8	+.786	67.1	-.656
48	even....	5.1	+2.425	24.3	+1.033	48.8	+.044	67.4	-.669
49	a.....	60.6	-.399	72.8	-.900	86.3	-1.622	98.4	-3.182
50	penny....	3.4	+2.706	13.6	+1.629	35.7	+.543	63.6	-.516

Figures 26, 27, and 28 give the scales for these words. In Figure 27 it is indicated below the line with the omission of the six words noted in the last paragraph. Above the line the words of the Preferred List are reproduced from Figure 14. Since the Easy 50-Word Test was also given to 4th-grade children it is likewise scaled for that grade omitting the same six words. (Fig. 25, 4th grade, lower line.)

We have, therefore, scales for every grade from the first half of the second grade to and including the eighth. All of these scales above the 2d grade are much richer than were those given in Section 12. There are fewer gaps in them and their range is greater. They may be used to great advantage in testing the spelling ability of children in any grade of the elementary school in which children are supposed to have any such ability. If it is not convenient to use a whole scale, certain words differing in difficulty by approximately equal amounts may be selected. Groups of words may be made each of equal difficulty as a group, or each differing from the preceding group by a fixed amount. The position of each word shows the weight which ought to be assigned to it for test purposes.

Each of these grade scales refers to the median of the grade as the zero-point. In Figure 29 is shown a scale for all grades referring, as in Figure 20, to the median of the 3d grade as the zero-point. Above the line is shown the Preferred List as in Fig 20. Below it are arranged the words of Rice's Test; and on a parallel scale the Easy 50-Word List. Caution, however, ought to be observed in accepting too literally the showing of the last two lists. Rice's Test was not given to the 3d grade, and the Easy 50-Word Test was given to the 2d grade and was not given above the 4th. They cannot, therefore, be closely compared with the Preferred List. The effect of high grades is to make the words harder, of low grades to make them easier. In the case of the Rice Test the words are probably a little—but only a little—too far to the right,—i.e., farther toward the high end than they would have been had they been used in the 3d grade—as Cornman used them. In the case of the Easy 50-Word Test the words would be a great deal too far to the left if set down as the record indicated. The six words common

0 80 + 220 + 240

35 48

0 32 4  
4 12 13 31

+ + 100 + 120

2 9 1 19  
4 8 7 45 14 40 23 29 49 47  
31 50 46

65 690 710  
+ 18 + 220 + 240

2 10 33 19  
22 49 7 44 30 23 24 47 37 1  
31 18 45 31 16 4 32 27 61 6 8  
47

2 46 150 Word Test (C)

2 of List being at + 685

-260 -240 -220 -200 -180 -160 -140 -120 -100 -80 -60 -40 -20 0 +20 +40 +60 +80 +100 +120 +140 +160 +180 +200 +220 +240 +260 +280 +300 +320 +340 +360 +380



19.26

2a and 2b Grade Scales, Easy  
50-Word List Part XXXX

$2b \longrightarrow \frac{1}{2} 20 16 24 25 11 19 2 26 22 20 45 121 20 31 16 92 27 28 3 23 \frac{3}{2} \frac{1}{2} 21 40 104 28 35 33 29 24 \frac{4}{2} 27 12 13 34$

- 320 - 300

### Preferred Text: 80-Word Text

Tables XVII and XVIII

-320 -300 -280 -260 -240 -220 -200 -180 -160 -140 -120 -100 -80 -60 -40 -20 0 +20 +40 +60

6 7 9  $\frac{11}{2}$  25 16 19 14 22 130 45  $\frac{46}{29}$  41 26 18 12 27 28 3 39 28 5 21  $\frac{10}{32}$  38 37 15 33 50 47 12 46

Fig. 28. General Scale for Grades 2 to 4  
 Easy 50-Word List Table XXXX—  
 Point of reference, 3<sup>rd</sup> Grade Median.

- 240 250 270 290 310 330 350 370 390 410 430 450 470 490 510 530 550 570 590 610 630 650 670 690 710 730 750 770 790 810 830 850 870 890 910 930 950 970 990

Fig. 29. General Scale. Grade 20-5"

Preferred List. Rice Sentence Test. 80%

50-Word List Tables III, XXX and XXXI  
Point of Reference—3<sup>rd</sup> Grade Medium.  
(Lower Figures) Top figures refer to  
Absolute Zero.

Preferred List →

Figs. 26-29. For the various lists referred to, see Appendix II. The scale for Fig. 29 is not complete, word 83 of the Rice List being at +4.68% from the 2d-grade median, or 1.115% from absolute zero.

to this list and to the Preferred List enable us to suggest a correction. Their P.E. values, when the averages of the grades writing them are taken, appear as follows:

	Easy 50- word List	Preferred List	Increase
sure.....	+ .530	+1.57	1.04
front.....	—.299	+1.06	1.36
touch.....	+ .652	+1.71	1.06
only.....	—.089	— .57	.66
pretty.....	—.024	+1.31	1.33
even.....	—.097	+ .70	.80
		Average Increase	1.04

It appears, therefore, that in order to compare the words of the Easy 50-Word List with those of the Preferred List and to scale them together we ought to raise all the words of the former list about 1 P.E. In Figure 29, accordingly, all these words have been raised that amount.

Fig. 29 shows our most complete scale. It has decided limitations, and it is impossible—in the case of the newly added words—to suppose that it is more than an approximation. A great deal more testing than we have been able to do will have to be done before these words and others with them can be precisely fixed beyond dispute. It is not claimed that the scale we give is final. We think, however, that, supposing the two fundamental assumptions upon which it is based to be valid, it may be used in its present form with substantially accurate results; and we are confident that the general method by which it has been derived is the one by which a final scale may ultimately be secured.

The top figures in Fig. 29 refer to the absolute zero-point, taken as 470 below the 3d-grade median. It enables us to state not only the difference in difficulty between words but their relationships. We may say, for instance, that *school* (No. 27 E. 50-W. L., scales at 428) is one-half as hard as *grateful* (No. 51 R. S. T., scales at 856). We may put certain facts in equation form as follows:

$$\begin{aligned}
 in &= \frac{1}{2} \text{ light} = \frac{1}{3} \text{ pigeons} = \frac{1}{4} \text{ fatiguing} \\
 is &= \frac{1}{2} \text{ also} = \frac{1}{3} \text{ occasion} = \frac{1}{4} \text{ conscientious} \\
 the &= \frac{1}{2} \text{ chicken} = \frac{1}{3} \text{ approval} \\
 and &= \frac{1}{2} \text{ penny} = \frac{1}{3} \text{ peculiar}
 \end{aligned}$$



to this list and to the Preferred List enable us to suggest a correction. Their P.E. values, when the averages of the grades writing them are taken, appear as follows:

	Easy 50-word List	Preferred List	Increase
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front.....	— .299	+1.06	1.36
touch.....	+ .652	+1.71	1.06
only.....	— .089	— .57	.66
pretty.....	— .024	+1.31	1.33
even.....	— .097	+ .70	.80
		Average Increase	1.04

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$in = \frac{1}{2}$   $light = \frac{1}{3}$   $pigeons = \frac{1}{4}$   $fatiguing$   
 $is = \frac{1}{2}$   $also = \frac{1}{3}$   $occasion = \frac{1}{4}$   $conscientious$   
 $the = \frac{1}{2}$   $chicken = \frac{1}{3}$   $approval$   
 $and = \frac{1}{2}$   $penny = \frac{1}{3}$   $peculiar$

Many more such statements may be made. It will, we think, surprise most people to learn that *fatiguing* is only four times as hard as *he*, or that to spell *occasion* shows but three times as much ability as to spell *is*.

In fact it will, we think, be seriously questioned whether such words as *at*, *of*, *on*, *do*, etc., have difficulties anything like as great as is shown on our scale. It will be asked, What words can be easier than these? If a child cannot spell them does he not show zero ability? The answer is that if one or more of these very easy words were isolated and pronounced to a group to be written, those who could not spell them would indeed show no spelling ability. But these words were not isolated, they were given in a context. It is one thing for children to write the word "at" when pronounced alone or in column dictation. It is quite another to write it in the sentence: "They are not at all pretty." Some will omit it, and this fault is not confined by any means to the lowest classes. Some will connect it with the word *all*, because they habitually do so in speaking. Some little children will quite break down on the whole sentence because they can't get over the word "they." In other sentences some will substitute a word (generally of similar meaning) for the one dictated. Each of these faults scores "wrong," and none of them would be made in column dictation. It is also true that children writing sentences more often write illegibly than they do when writing a few words in columns; and this is particularly true with young children.

It will therefore be clear that the decision as to how hard a word is, depends on how you use it in testing and when you call it "wrong." To verify the placings of the words given in this study one ought to use the same test material and the same method of scoring. In particular, column dictation will not do at all.

#### § 19. *Derived Forms of Distribution*

The foregoing treatment of the measurement of spelling ability has, as has been indicated frequently, proceeded upon the assumption that the distribution of ability is in all grades normal. Such an assumption has always been made in the investigation of school abilities by persons whose knowledge of

the theory of statistics has enabled them to do so. In Section 10 I have said: "There seems no good ground for assuming that the distribution of spelling ability in any grade is not according to the normal curve *or according to a curve which resembles it closely.*" By this alternative is suggested the possible applicability of certain curves not of normal form but resembling the normal form. Our problem will now be to derive and apply to some of our material such modifications of the type form of distribution as our present knowledge of grade conditions permits.

In order that the frequency of measurements within a group may be distributed according to the Probability Integral it is necessary that the group be in no way selected on the basis of the characteristic that is measured. It must be a random sampling from a "total population." If the frequency distributions of statures for adult males born in the City of New York may be expected to approximate the symmetrical type, the distributions of statures for adult males on the police force of New York City would not do so. Their curve will be of the "moderately asymmetrical type" being cut off at the low end because extremely short men are at a disadvantage in the group supposed to be measured. In other words, there is a selection on the basis of stature. The group "adult males on the police force of New York City" is not a random sampling of the total population "adult males of New York City."

The question then is: To what extent does the membership of each grade of the elementary school fail of being a chance selection from a total population? We may fairly assume, in the first place, that the pupils of the first and second grades are unselected. Practically all children attend school and none drop out in these grades. From the 3d grade on, however, each successive grade constitutes a group which is less and less a random sampling. Many influences are at work to eliminate a greater and greater number of individuals. Probably the most important of them is the inability of children to progress—i.e., lack of ability in the lines of work now required by the schools.

The extent to which elimination takes place in the grades has been the subject of study by a number of investigators. The first of these was Thorndike ('07). He draws conclusions from

conditions in 23 cities as they were about 1900. He estimates that out of 100 entering pupils, 97 remain till grade 3, 90 till grade 4, 81 till grade 5, 68 till grade 6, 54 till grade 7, and 40 till the last grammar grade (8th or 9th). Ayres ('09) sharply criticised these figures, stating that they were too small. He contended, particularly, that there was no dropping out before the 6th year—a conclusion which common observation and later investigation unite to disprove. Employment certificates are granted in great numbers to 5th-grade children. Mr. Ayres' figures for retention are as follows: Grades 1-5, 100 (i.e., no elimination); grade 6, 90; grade 7, 71; grade 8, 51.

Thorndike, using later and better reports, subsequently derived figures a little higher than his former ones, but substantially in agreement with them (Thorndike, '10). They were no higher probably than 5 or 6 years of agitation would have led one to expect.

Another important study of this question was made by Strayer ('11), the material being used from 318 cities. His conclusions tend to group with Thorndike's rather than with those of Ayres. Owing to the large number of cities whose returns were used, the uniform method of taking the census, and the recency of the conditions studied, this investigation is highly important. No single figures are given for retention in general, though they are easily found. Using the largest age group as the number of entering children, he gives the following as the median per cents in each grade.

	Cities of Over 25,000		Cities of Less than 25,000	
	Boys	Girls	Boys	Girls
3d year.....	115	110	110	105
4th " .....	110	110	105	100
5th " .....	100	95	95	95
6th " .....	85	85	80	85
7th " .....	65	75	70	70
8th " .....	50	60	50	60

Since in this study we group boys and girls together and consider general conditions, the average of these percentages will give figures for retention for each grade (subject to deduction for

repeaters) as follows: 3d grade, 110; 4th grade, 106; 5th grade, 96; 6th grade, 84; 7th grade, 70; 8th grade, 55. If, as Dr. Strayer says, a fair estimate of the number of repeaters in the 6th, 7th, and 8th grades would be 12%, 10%, and 8% of the pupils in each grade (p. 136), it is likely that the progression (8, 10, 12) may be carried back to the 5th, 4th and 3d grades without great violence to the facts. We estimate therefore that the number of repeaters in the 3d, 4th, and 5th grades is 18%, 16%, and 14% of the pupils in each grade. Making these deductions from the above percentages, we have for the retention: 3d grade, 92; 4th grade, 90; 5th grade, 82; 6th grade, 72; 7th grade, 60; 8th grade, 47.

Weighing as best we can the results of these four studies, we have made the best estimate we can for the probable amount of retention at present in the grades. For reasons that will appear later we have expressed this estimate in numbers per 10,000 instead of per 100.

Table XXXIII and Fig. 30 show the percentages we have adopted compared with those of Thorndike, Ayres, and Strayer (as derived). Fig. 30 gives only the earlier of Thorndike's percentages.

TABLE XXXIII  
PERCENTAGES OF RETENTION. GRADES 3 TO 8

	3d	4th	5th	6th	7th	8th
Thorndike '07.....	97	90	81	68	54	40
Ayres '09.....	100	100	100	90	71	51
Thorndike '10.....	91	81.5	70.9	56	41.2	
Strayer '11 (derived).....	92	90	82	72	60	47
Adopted.....	97.25	95.46	88.40	70.87	57.44	48.21

Such an amount of retention for each grade having been adopted, the next question to consider is: What part of a normal distribution is thus eliminated? Obviously not all the poorest in ability drop out. Our results for spelling show that some very poor spellers are retained even in the highest grades. Yet the greatest elimination will no doubt be among those of lowest ability and will be progressively less among children of greater ability. How much this amounts to for successive incre-

ments of ability we do not positively know. We are again forced to make as reasonable an estimate as we can, and this time without the help of any investigations.

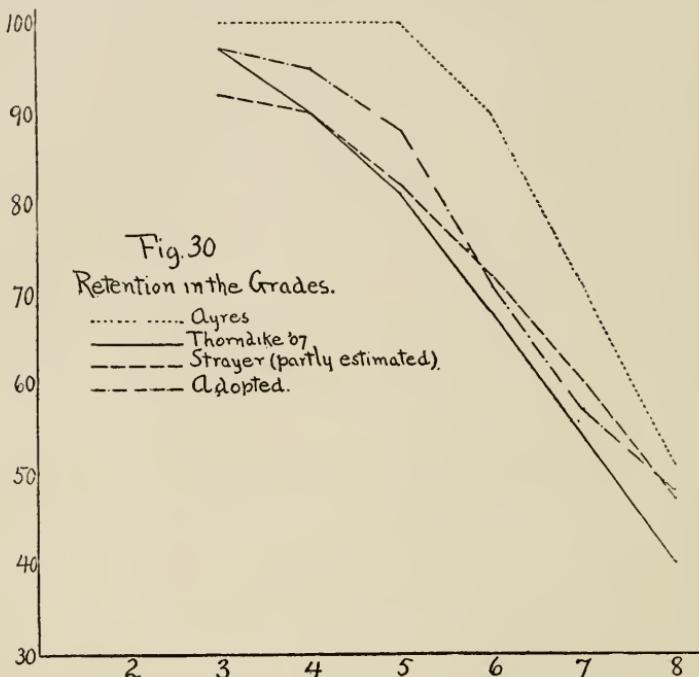


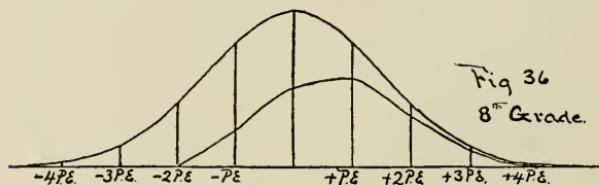
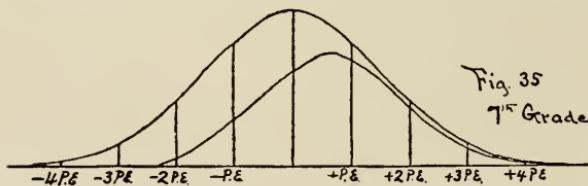
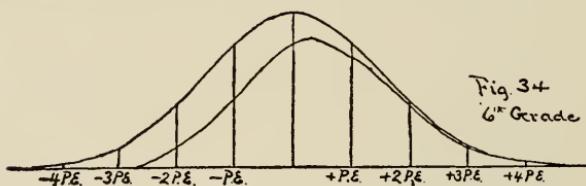
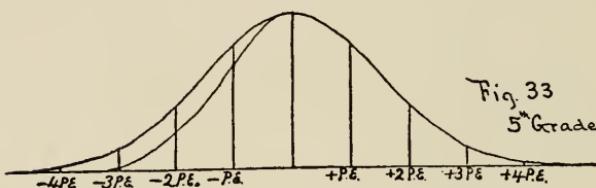
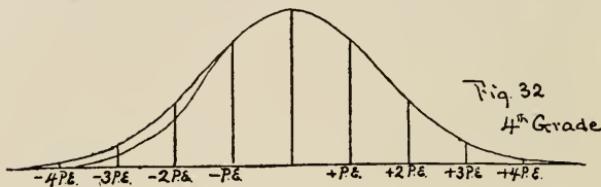
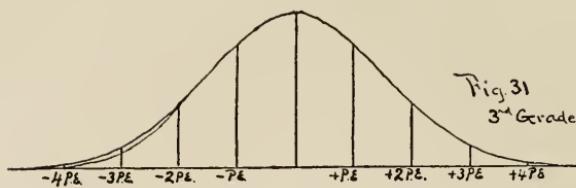
FIG. 30. The horizontal scale is for the grades of the elementary school; the vertical scale is for percentage of pupils retained.

We have estimated (Table XXXIII) that 9725 out of 10,000 entering children are retained in the 3d grade; and we judge further that all below — 4 P.E. have dropped out, that at — 3 P.E. 40% have dropped out, and that at — 2 P.E. none at all. In the 4th grade, retention is put at 9546 in 10,000 (Table XXXIII) and total elimination is estimated to operate up to — 3.7 P.E. From this point to — 2.7 P.E. the force of elimination is supposed gradually to diminish until 40% drop out. At — 1.7 P.E. only 10% are estimated as lost to the grade. At — 1.2 P.E. the forces tending to eliminate children are supposed to have been completely counteracted by the opposing forces tending to retain them. In the 5th grade (8840 out of 10,000 retained) the elimination is

assumed to be total up to — 3.2 P.E. and partial as high as — 0.2 P.E. In the 6th grade (7087 out of 10,000 retained) the corresponding points are — 2.7 P.E. and + 3.3 P.E.; in the 7th (5744 retained) they are — 2.3 P.E. and + 3.7 P.E.; and in the 8th (4821 retained), — 2 P.E. and + 6 P.E. It is, therefore, supposed that in the last three years of the elementary school there is some elimination even among the most capable children. This plan of elimination and retention may easily be attacked as artificial and it may very likely be shown to need considerable modification when later and better knowledge is available on this difficult subject. Meanwhile, however, some assumption was necessary in order to construct any sort of frequency tables which should illustrate the method of constructing a scale when account is taken of the selective influence of the grades. We can only state that we have keenly appreciated the importance of distributing the amount of elimination where it most probably occurs, that we have been at no small pains to find out where to distribute it, and that we have estimated as wisely as we could. Table XXXIV gives the entire plan of elimination and retention for each grade.

TABLE XXXIV  
PLAN OF ELIMINATION AND RETENTION FOR EACH GRADE

Grade, etc.	$\frac{X}{P.E.}$	Per cent eliminated	Per cent retained	Grade, etc.	$\frac{X}{P.E.}$	Per cent eliminated	Per cent retained
3d Grade. $N=9725$ .	—4	100	0	7th Grade $N=5744$ .	—2.3	100	0
	—3	40	60		—1.3	70	30
	—2	0	100		—0.3	50	50
4th Grade $N=9546$ .	—3.7	100	0		+0.7	20	80
	—2.7	40	60		+1.7	10	90
	—1.7	10	90		+2.7	5	95
	—1.2	0	100		+3.7	0	100
5th Grade $N=8840$ .	—3.2	100	0	8th Grade $N=4821$ .	—2	100	0
	—2.2	50	50		—1	70	30
	—1.2	20	80		0	50	50
	—0.2	0	100		+1	30	70
6th Grade $N=7087$ .	—2.7	100	0		+2	20	80
	—1.7	60	40		+3	10	90
	—0.7	35	65		+4	6	94
	+0.3	15	85		+5	2	98
	+1.3	10	90		+6	0	100
	+2.3	5	95				
	+3.3	0	100				



Figs. 31-36. The estimated amount and distribution of elimination and retention. See Table XXXIII.

The next step was to apply the data of Table XXXIV to the normal distribution and to derive therefrom for each grade a modified distribution which should take account of the amount and range of elimination as estimated. In order that the validity of our method may be open to inspection, we shall illustrate for the 6th grade the manner in which these modified distributions were derived.

We have adopted certain percentages of retention for designated amounts of general ability (Table XXXIV, 6th grade), and these percentages must not only stand the test of reasonableness in themselves, but they must also when applied to a normal table of frequency (the sum of whose cases is, say, 1000), reduce the number of cases to an amount which represents a reasonable percentage of retention for the 6th grade (say, 70 or 71). That is, the derived table must show approximately 700 cases out of 1000, or 7000 out of 10,000. We shall see later to what extent this turns out to be true.

Adapting the normal table of frequency (Table XIV, page 35) so as to include 1000 cases instead of 10,000 and taking intervals of 0.1 P.E., we have columns 1 and 2 of Table XXXV. In column 3 we increase the percentages of retention from 0 at  $-2.7$  P.E. to 40 at  $-1.7$  P.E. by increments of 4 for each of the ten steps; then by increments of 2.5 until 65 is reached at  $-0.7$  P.E.; then by increments of 2 to 85 at  $+0.3$  P.E.; and so on as required by Table XXXIV, col. 4. Taking these percentages of the frequencies in column 2 gives the derived frequencies of column 4. The sum of the entries in this column being 708.7, the plan gives an amount of elimination which is reasonable for the 6th grade. (See Table XXXIII.)

The amount and distribution of elimination and retention are shown by diagram for each grade in Figs. 31 to 36. Fig. 34 in particular shows these facts for the 6th grade, and is the graphic representation of the series of frequencies in column 4 of Table XXXV. Fig. 31 shows the same facts for the 3d grade, Fig. 32 for the 4th grade, etc. The progressive increase in elimination and the extension of it to higher and higher parts of the normal curve are the facts to be noticed.

But we have not in column 4 of Table XXXV, a frequency table for the 6th grade in the most useful form. The area of its

X P.E.	Normal Frequencies	Per- cent- ages of Reten- tion	Derived Frequencies	Same on basis of 10,000 cases	X P.E.	Normal Frequencies	Per- cent- ages of Reten- tion	Derived Frequencies	Same on basis of 10,000 cases
0—.1	27	79	21.3	301	0—.1	27	81	21.9	309
.2	27	77	20.8	293	.2	27	83	22.4	312
.3	26	75	19.5	275	.3	26	85	22.1	316
.4	26	73	19.0	268	.4	26	85.5	22.2	316
.5	26	71	18.5	261	.5	26	86	22.4	313
.6	25	69	17.3	244	.6	25	86.5	21.6	308
.7	25	67	16.8	237	.7	25	87	21.8	305
.8	23	65	15.0	212	.8	23	87.5	20.1	284
.9	23	62.5	14.4	203	.9	23	88	20.2	285
1.0	22	60	13.2	186	1.0	22	88.5	19.5	275
1.1	21	57.5	12.1	171	1.1	21	89	18.7	264
1.2	20	55	11.0	155	1.2	20	89.5	17.9	252
1.3	19	52.5	10.0	141	1.3	19	90	17.1	241
1.4	18	50	9.0	127	1.4	18	90.5	16.3	230
1.5	16	47.5	7.6	107	1.5	16	91	14.6	206
1.6	16	45	7.2	102	1.6	16	91.5	14.6	206
1.7	14	42.5	6.0	85	1.7	14	92	12.9	182
1.8	14	40	5.6	79	1.8	14	92.5	13.0	183
1.9	12	36	4.3	61	1.9	12	93	11.2	158
2.0	11	32	3.5	50	2.0	11	93.5	10.3	145
2.1	11	28	3.1	44	2.1	11	94	10.3	145
2.2	9	24	2.2	31	2.2	9	94.5	8.5	121
2.3	9	20	1.8	26	2.3	9	95	8.6	120
2.4	7	16	1.1	16	2.4	7	95.5	6.7	95
2.5	7	12	.8	11	2.5	7	96	6.7	95
2.6	6	8	.5	7	2.6	6	96.5	5.8	82
2.7	6	4	.2	3	2.7	6	97	5.8	82
2.8	5	o	0	0	2.8	5	97.5	4.9	69
					2.9	4	98	3.9	55
					3.0	4	98.5	3.9	55
					3.1	3	99	3.0	42
					3.2	3	99.5	3.0	42
					3.3	2	100	2.0	28
					3.4	2	100	2.0	28
					3.5	2	100	2.0	28
					3.6	2	100	2.0	28
					3.7	1	100	1.0	14
					3.8	1	100	1.0	14
					3.9	1	100	1.0	14
					4.0	1	100	1.0	14
					etc. to 6.0	etc. to .02	etc.	etc. to .02	etc. to .28
Total No. cases.....						1000		708.7	9999.72

curve is no longer 1000, but only 708.7. In order to express the several frequencies in the form of per cents, we shall have to divide each of them (column 4) by their total (708.7). Expressing these quotients on the basis of 10,000 instead of 1000, we have column 5. These are the numbers in the columns 3 and 5 of Table XXXIX (p. 96); and when their sums are taken beginning at 0 they constitute the Modified Table of Frequency for the 6th grade (Table XXXIX).

TABLE XXXVI

MODIFIED TABLE OF FREQUENCY, 3D GRADE. MEDIAN = +0.051 P.E.

Plan of elimination: —4 P.E., 100%; —3 P.E., 40%; —2 P.E., 0%. Total area of the surface of frequency taken as 10,000. See Fig. 37.

X	Low		High		X	Low		High		X	Low		High		
	P.E.	%	△	%	△	P.E.	%	△	%	△	P.E.	%	△	%	△
.1	278	278	278	278	2.1	4334	109	4338	113	4.1			5116.1	5.1	
.2	556	278	556	278	2.2	4419	85	4431	93	4.2			5121.2	5.1	
.3	823	267	823	267	2.3	4500	60	4524	72	4.3			5126.3	4.1	
.4	1090	267	1090	267	2.4	4560	58	4596	72	4.4			5130.4	2.1	
.5	1357	257	1357	257	2.5	4618	47	4668	62	4.5			5132.5	2.1	
.6	1614	257	1614	257	2.6	4665	44	4730	62	4.6			5134.6	1.0	
.7	1871	236	1871	236	2.7	4709	35	4792	62	4.7			5135.6	1.0	
.8	2107	236	2107	236	2.8	4744	26	4843	41	4.8			5136.6	1.0	
.9	2343	226	2343	226	2.9	4770	25	4884	41	4.9			5137.6	1.0	
1.0	2569	216	2569	216	3.0	4795	17	4925	31	5.0			5138.6	.51	
1.1	2785	206	2785	206	3.1	4812	15	4956	31	5.1			5139.11	.51	
1.2	2991	195	2991	195	3.2	4827	9	4987	21	5.2			5139.62	.31	
1.3	3186	185	3186	185	3.3	4836	7.4	5008	21	5.3			5139.93	.31	
1.4	3371	165	3371	165	3.4	4843.4	6.2	5029	21	5.4			5140.24	.31	
1.5	3536	165	3536	165	3.5	4849.6	4.9	5050	21	5.5			5140.55	.31	
1.6	3701	144	3701	144	3.6	4854.5	1.9	5071	10	5.6			5140.86	.21	
1.7	3845	144	3845	144	3.7	4856.4	1.2	5081	10	5.7			5141.07	.21	
1.8	3989	123	3989	123	3.8	4857.6	0.6	5091	10	5.8			5141.28	.21	
1.9	4112	113	4112	113	3.9	4858.2		5101	10	5.9			5141.49	.21	
2.0	4225	4225	4225	4.0				5111	10	6.0			5141.70	.21	

TABLE XXXVII

MODIFIED TABLE OF FREQUENCY, 4TH GRADE. MEDIAN = +0.087 P.E.

Plan of elimination: —3.7 P.E., 100%; —2.7 P.E., 40%; —1.7 P.E., 10%; —1.2 P.E., 0%. Total area of the surface of frequency taken as 10,000. See Fig. 38.

X	Low		High		X	Low		High		X	Low		High		
	P.E.	%	△	%	△	P.E.	%	△	%	△	P.E.	%	△	%	△
.1	283	283		283		2.1	4316		93	4421	115	4.1		5210.2	5.2
.2	566	566		272	272	2.2	4390		74	4515	94	4.2		5215.4	5.2
.3	838	838		2.3	4461		71		4609	94		4.3		5220.6	5.2
.4	1110	1110		2.4	4514		53		4682	73		4.4		5224.8	4.2
.5	1381	1381		2.5	4565		51		4755	73		4.5		5226.9	2.1
.6	1643	1643		2.6	4606		40		4818	63		4.6		5229	1.05
.7	1905	1905		2.7	4646		31		4881	52		4.7		5230.05	1.05
.8	2146	2146		2.8	4677		23		4933	42		4.8		5231.10	1.05
.9	2387	2387		2.9	4700		20		4975			4.9		5232.15	
1.0	2617	2617		3.0	4720		13		5017			5.0		5233.20	1.05
1.1	2837	2837		3.1	4733		11		5048	31		5.1		5233.72	.52
1.2	3047	3047		3.2	4744		6		5079	21		5.2		5234.24	.31
1.3	3246	3246		3.3	4750		5		5100			5.3		5234.55	.31
1.4	3431	3435		3.4	4755		4		5121			5.4		5234.86	
1.5	3592	3603		3.5	4759		3		5142			5.5		5235.17	.31
1.6	3750	158	168	3.6	4762		1		5163			5.6		5235.48	.31
1.7	3885	135	147	3.7	4763				5173.5			10.5		5235.69	.21
1.8	4017	132	147									10.5		5235.90	.21
1.9	4126	109	126	3.8					5184			5.8			
2.0	4223	97	115	3.9					5194.5			10.5		5236.11	.21
				4.0					5205			6.0		5236.32	

TABLE XXXVIII

MODIFIED TABLE OF FREQUENCY, 5TH GRADE. MEDIAN=+0.215 P.E.

Plan of elimination: —3.2 P.E., 100%; —2.2 P.E., 50%; —1.2 P. E., 20%; —0.2 P.E., 0%. Total area of the surface of frequency taken as 10,000. See Fig. 39.

X P.E.	Low		High		X P.E.	Low		High		X P.E.	Low		High	
	%	Δ	%	Δ		%	Δ	%	Δ		%	Δ	%	Δ
.1	305	305	305	305	2.1	4093	70	4772	124	4.1	5627	6		
.2	610	305	610	305	2.2	4147	54	4874	102	4.2	5633	6		
.3	904	294	904	294	2.3	4198	51	4976	102	4.3	5639	6		
.4	1192	288	1198	294	2.4	4234	36	5055	79	4.4	5644	5		
.5	1474	282	1492	294	2.5	4266	32	5134	79	4.5	5646	2		
.6	1740	266	1775	283	2.6	4290	24	5202	68	4.6	5648	2		
.7	2000	260	2058	283	2.7	4310	20	5270	68	4.7	5649	1		
.8	2234	234	2318	260	2.8	4324	14	5327	57	4.8	5650	1		
.9	2463	229	2578	249	2.9	4333	9	5372	45	4.9	5651	1		
1.0	2677	214	2827	249	3.0	4340	7	5417	45	5.0	5652	.6		
1.1	2877	200	3065	238	3.1	4343	3	5451	34	5.1	5652.6			
1.2	3063	186	3291	226	3.2	4345	2	5485	34	5.2	5653.1	.5		
1.3	3235	172	3506	215	3.3			5508	23	5.3	5653.4	.3		
1.4	3235	157	3506	204	3.4			5531	23	5.4	5653.7	.3		
1.5	3392	134	3710	181	3.5			5534	23	5.5	5654.0	.3		
1.6	3526	129	3891	181	3.6			5577	23	5.6	5654.3	.3		
1.7	3655	108	4072	158	3.7			5588	11	5.7	5654.5	.2		
1.8	3763	103	4230	158	3.8			5599	11	5.8	5654.7	.2		
1.9	3866	84	4388	136	3.9			5610	11	5.9	5654.9	.2		
2.0	3950	73	4524	124	4.0			5621	11	6.0	5655.1	.2		

TABLE XXXIX

MODIFIED TABLE OF FREQUENCY, 6TH GRADE. MEDIAN = +0.418 P.E.

Plan of elimination: —2.7 P.E., 100%; —1.7 P.E., 60%; —0.7 P.E., 35%; +0.3 P.E., 15%; +1.3 P.E., 10%; +2.3 P.E., 5%; +3.3 P.E., 0%. Total area of surface of frequency taken as 10,000. See Fig. 40.

P.E.	X		Low		High		P.E.	X		Low		High		P.E.	X		Low		High	
	%	Δ	%	Δ	%	Δ		%	Δ	%	Δ	%	Δ		%	Δ	%	Δ	%	Δ
.1	301	301	293	293	309	309	2.1	3602	3602	31	3633	3633	44	5235	5235	121	4.1	6268	6268	7
.2	594	594	275	275	621	621	2.2	3675	3675	26	3696	3696	16	5356	5356	120	4.2	6275	6275	7
.3	869	869	268	268	937	937	2.3	3696	3696	11	3717	3717	11	5476	5476	95	4.3	6282	6282	6
.4	1137	1137	261	261	1253	1253	2.4	3717	3717	7	3738	3738	95	5571	5571	4.4	4.4	6288	6288	3
.5	1398	1398	244	244	1566	1566	2.5	3738	3738	3	3759	3759	7	5666	5666	82	4.5	6291	6291	3
.6	1642	1642	237	237	1874	1874	2.6	3759	3759	3	3779	3779	3	5748	5748	82	4.6	6294	6294	1.4
.7	1879	1879	212	212	2179	2179	2.7	3779	3779	3	3800	3800	3	5830	5830	69	4.7	6295.4	6295.4	1.4
.8	2091	2091	203	203	2463	2463	2.8	3800	3800	3	3821	3821	3	5899	5899	55	4.8	6296.8	6296.8	1.4
.9	2294	2294	186	186	2748	2748	2.9	3821	3821	3	3842	3842	3	5954	5954	49	4.9	6298.2	6298.2	1.4
1.0	2480	2480	171	171	3023	3023	3.0	3842	3842	3	3863	3863	3	6009	6009	55	5.0	6299.6	6299.6	.7
1.1	2651	2651	155	155	3287	3287	3.1	3863	3863	3	3884	3884	3	6051	6051	42	5.1	6300.3	6300.3	.7
1.2	2806	2806	141	141	3539	3539	3.2	3884	3884	3	3905	3905	3	6093	6093	28	5.2	6301	6301	.4
1.3	2947	2947	127	127	3780	3780	3.3	3905	3905	3	3926	3926	3	6121	6121	28	5.3	6301.4	6301.4	.4
1.4	3074	3074	107	107	4010	4010	3.4	3926	3926	3	3947	3947	3	6149	6149	28	5.4	6301.8	6301.8	.4
1.5	3181	3181	102	102	4216	4216	3.5	3947	3947	3	3968	3968	3	6177	6177	28	5.5	6302.2	6302.2	.4
1.6	3283	3283	85	85	4422	4422	3.6	3968	3968	3	3989	3989	3	6205	6205	14	5.6	6302.6	6302.6	.28
1.7	3368	3368	79	79	4604	4604	3.7	3989	3989	3	4010	4010	3	6219	6219	14	5.7	6302.88	6302.88	.28
1.8	3447	3447	61	61	4787	4787	3.8	4010	4010	3	4031	4031	3	6233	6233	14	5.8	6303.16	6303.16	.28
1.9	3508	3508	50	50	4945	4945	3.9	4031	4031	3	4052	4052	3	6247	6247	14	5.9	6303.44	6303.44	.28
2.0	3558	3558	50	50	5090	5090	4.0	4052	4052	3	4073	4073	3	6261	6261	6.0		6303.72	6303.72	

TABLE XL

MODIFIED TABLE OF FREQUENCY, 7TH GRADE. MEDIAN==+0.669 P.E.

Plan of elimination: —2.3 P.E., 100%; —1.3 P.E., 70%; —0.3 P.E., 50%; +0.7 P.E., 20%; +1.7 P.E., 10%; +2.7 P.E., 5%; +3.7 P.E., 0%. Total area of frequency surface taken as 10,000. See Fig. 41.

X	Low		High		X	Low		High		X	Low		High		
	P.E.	%	△	%	△	P.E.	%	△	%	△	P.E.	%	△	%	△
.1	277	277		290	290	2.1	2844	17	5846	176	4.1	7096	9		
.2	540	263		306	308	2.2	2853	9	5991	145	4.2	7105	9		
.3	780	240		308	322	2.3	2858	5	6136	114	4.3	7114	7		
.4	1006	217		334	2.4				6250	114	4.4	7121	3		
.5	1223	1560		336	2.5				6364	99	4.5	7124	3		
.6	1423	200		348	2.6				6463	99	4.6	7127	2		
.7	1614	191		326	2.7				6562	83	4.7	7129	2		
.8	1783	169		2570	2.8				6645	66	4.8	7131	2		
.9	1943	160		326	2.9				6711	4.9		7133	2		
1.0	2089	146		318	3.0				6779	68	5.0	7135	.9		
1.1	2221	132		306	3.1				6829	50	5.1	7135.9	.9		
1.2	2339	118		296	3.2				6879	50	5.2	7136.8	.5		
1.3	2445	106		283	3.3				6914	35	5.3	7137.3	.5		
1.4	2539	94		273	3.3				6949	35	5.4	7137.8	.5		
1.5	2614	75		246	3.4				6984	35	5.5	7138.3	.5		
1.6	2680	66		246	3.5				7019	35	5.6	7138.8	.35		
1.7	2730	50		220	3.6				7036	17	5.7	7139.15	.35		
1.8	2773	43		220	3.7				7053	17	5.8	7139.50	.35		
1.9	2804	31		190	3.8				7070	17	5.9	7139.85	.3		
2.0	2827	23		176	3.9				7087	17	6.0	7140.15			

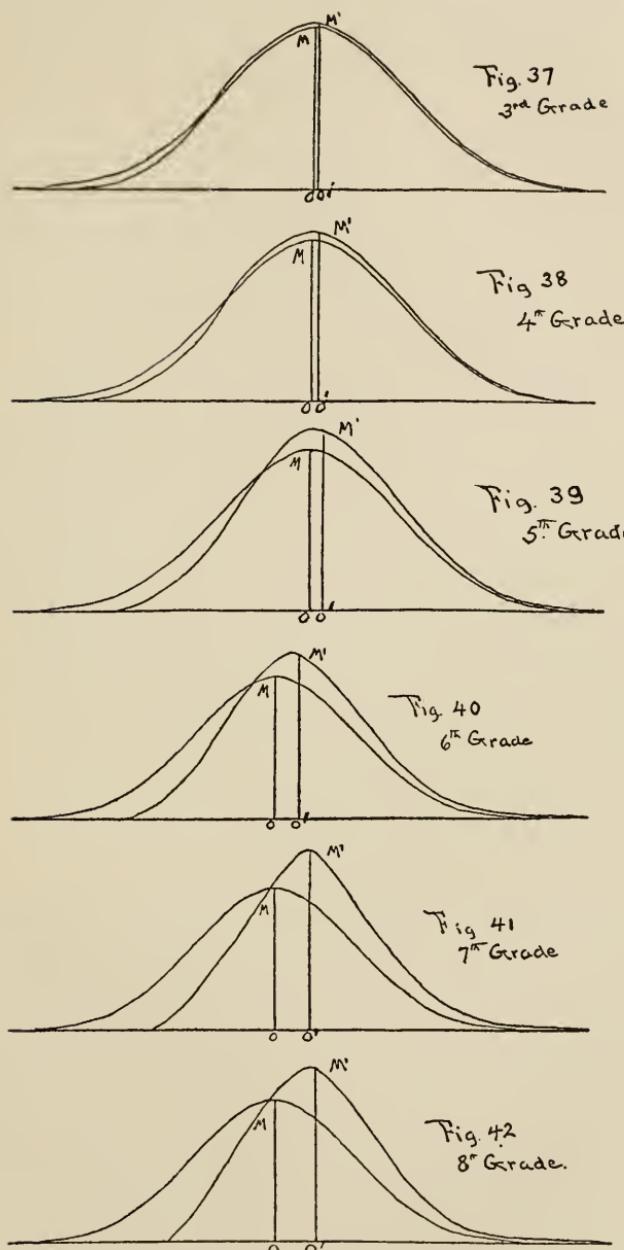
TABLE XLI

MODIFIED TABLE OF FREQUENCY, 8TH GRADE. MEDIAN = +0.746 P.E.

Plan of elimination: —2 P.E., 100%; —1 P.E., 70%; 0 P.E., 50%; +1 P.E., 30%; +2 P.E., 20%; +3 P.E., 10%; +4 P.E., 6%; +5 P.E., 2%; +6 P.E., 0%. Total area of frequency surface taken as 10,000. See Fig. 42.

X	Low			High			X	Low			High			X	Low			High		
	P.E.	%	△	P.E.	%	△		P.E.	%	△	P.E.	%	△		P.E.	%	△	P.E.	%	△
.1	280	280		290	290		2.1				5834	184		4.1				7195	10	
.2	550	270		593	303		2.2				5999	165		4.2				7205	10	
.3	799	249		896	303		2.3				6144	145		4.3				7215	10	
.4	1036	237		1209	313		2.4				6274	130		4.4				7223	8	
.5	1262	226		1532	323		2.5				6390	116		4.5				7227	4	
.6	1469	207		1855	323		2.6				6498	108		4.6				7231	2	
.7	1666	197		2187	320		2.7				6606	108		4.7				7233	2	
.8	1838	172		2507	319		2.8				6697	91		4.8				7235	2	
.9	2000	162		2826	319		2.9				6772	75		4.9				7237	2	
1.0	2145	145		3145	319		3.0				6847	75		5.0				7239	2	
1.1	2276	131		3454	309		3.1				6903	56		5.1				7240	1	
1.2	2388	95		3753	288		3.2				6959	38		5.2				7241	.6	
1.3	2483	79		4041	276		3.3				6997	38		5.3				7241.6	.6	
1.4	2562	60		4317	260		3.4				7035	37		5.4				7242.2	.6	
1.5	2622	50		4577	242		3.5				7072	37		5.5				7242.8	.6	
1.6	2672	35		4819	235		3.6				7109	19		5.6				7243.4	.6	
1.7	2707	27		5054	215		3.7				7128	19		5.7				7243.8	.4	
1.8	2734	14		5269	197		3.8				7147	19		5.8				7244.2	.4	
1.9	2748	6		5466	184		3.9				7166	19		5.9				7244.6	.4	
2.0	2754			5650			4.0				7185	6.0						7245		

In this manner each of the Modified Tables of Frequency was made up. They are given in tables XXXVI to XLI. They are intended to take the place, each for the grade to which it applies, of the Table of Frequency for the normal distribution. Since they are asymetrical, the lower and upper parts have to be given separately. For the same reason there is no P.E., the use of the Probable Error as a unit of amount being properly confined to normal curves only (Yule, '11, p. 147). The quartile deviation ( $Q_3 - Q_1$ ) might be used instead, but its



Figs. 37-42. Derived Forms of Distribution. Grades 3 to 8.

value differs for each of the six tables. In order therefore to employ a unit which should be the same for all, including the normal distribution, we have retained the P.E. of the Probability Integral. It is now no longer a function of the modified distributions, but a mere unit of length. Likewise in order to have a common point of reference the median of the normal distribution has been retained, the terms "low" and "high" in the tables referring to parts below or above that point. The real median of each modified distribution, however, is given, being expressed as a deviation from the old median.

Figs. 37 to 42 are to be considered in connection with tables XXXVI to XLI, of which they are the graphic expressions (the curves being "smoothed," to represent an indefinite number of cases). They are also to be considered in connection with Figs. 31 to 36, from the "retention" parts of which they are derived by making the areas 10,000. In Figs. 37 to 42, the curve extending farther to the left is in each case the normal curve and  $OM$  is its median vertical.  $O^1M^1$  is the median vertical of the modified surface and  $OO^1$  is the distance between medians. The values of these are as follows: 3d grade, 0.051 P.E.; 4th grade, 0.087 P.E.; 5th grade, 0.215 P.E.; 6th grade, 0.418 P.E.; 7th grade, 0.669 P.E.; 8th grade, 0.746 P.E.

Is it worth while to use these tables instead of the normal one? Will the same material when analyzed by the skew and normal distributions yield differences that are important? With the purpose of throwing some light on this question we have used the modified tables to interpret the results of testing with our Preferred List, and the rest of the present section will be devoted to this matter. The differences will not in many cases be found to be large. This is, of course, particularly true when the early grades are concerned, the curves being for those grades almost normal. It may be remarked, however, that the applicability of these tables does not rest upon the results here shown. It is general ability rather than spelling ability that tends strongly to keep children in school. Spelling ability does not correlate as highly with general ability as do the abilities in most other school subjects. It is quite likely, therefore, that

the use of these tables for the statistical treatment of other subjects may be more satisfactory than it is for spelling. They are given here primarily to illustrate the method.

TABLE XLII

NUMBER AND PER CENT OF PUPILS IN EACH GRADE WHOSE ABILITY EQUALLED OR EXCEEDED THAT OF THE MEDIAN PUPIL IN EVERY OTHER GRADE WITH THE P.E. VALUES CORRESPONDING TO EACH PER CENT. SELECTED LIST. MODIFIED DISTRIBUTIONS. COMPARE WITH TABLE XV (p. 36)

		3d Grade	4th Grade	5th Grade	6th Grade	7th Grade	8th Grade
3d grade...	No.		76	27	9	3	0
$N=445$	%		17.1	6.1	2.0	0.7	0
	P.E.		1.3858	2.2736	3.0029	3.607	?
4th grade...	No.	378		146	52	27	9
$N=467$	%	80.9		31.3	11.1	5.8	1.9
	P.E.	1.1949		.6965	1.7616	2.2778	3.0076
5th grade...	No.	478	370		142	73	30
$N=515$	%	92.8	71.8		27.6	14.2	5.8
	P.E.	1.7916	.7341		.8136	1.5172	2.2104
6th grade...	No.	414	384	338		142	57
$N=418$	%	99.0	91.9	80.1		34.0	13.6
	P.E.	2.5043	1.6747	1.0451		.5386	1.4812
7th grade...	No.	363	354	328	256		99
$N=365$	%	99.5	96.4	89.9	70.1		27.1
	P.E.	2.6038	2.0360	1.5096	.6586		.7564
8th grade...	No.	227	276	269	241	200	
$N=277$	%	100	99.6	97.1	87.0	72.2	
	P.E.	?	2.4719	2.0197	1.4424	.635	

In Section 11 we located the grade medians assuming normal distribution. In Tables XLII and XLIII the same data have been subjected to analysis using the modified distributions. These tables are to be compared with Tables XV (page 36) and XVI (page 39). The median intervals are considerably less than they were found to be by using the normal distribution. Note the comparisons in Table XLIV (page 103).

On the average, the intervals by the present method are less than the same intervals found by using the normal distribution by 0.1247 P.E., or about half a step in the 10-point scale (Table XX, page 52). Since this occurs five times the entire range

TABLE XLIII

DIRECT AND DERIVED VALUES OF MEDIAN DISTANCES. MODIFIED DISTRIBUTIONS. SELECTED LIST

	$M_{3-4}$	$M_{4-5}$	$M_{5-6}$	$M_{6-7}$	$M_{7-8}$
	1.3858 (direct)	.8878 ( $M_{3-5}—M_{3-4}$ )	.7293 ( $M_{3-6}—M_{3-5}$ )	.6041 ( $M_{3-7}—M_{3-6}$ )	? ( $M_{3-8}—M_{3-7}$ )
	1.5771 ( $M_{3-5}—M_{4-5}$ )	.6965 (direct)	1.0651 ( $M_{4-6}—M_{4-5}$ )	.5162 ( $M_{4-7}—M_{4-6}$ )	.7298 ( $M_{4-8}—M_{4-7}$ )
	1.2413 ( $M_{3-6}—M_{4-6}$ )	.9478 ( $M_{4-6}—M_{5-6}$ )	.8136 (direct)	.7036 ( $M_{5-7}—M_{5-6}$ )	.6932 ( $M_{5-8}—M_{5-7}$ )
	1.3292 ( $M_{3-7}—M_{4-7}$ )	.7606 ( $M_{4-7}—M_{5-7}$ )	.9786 ( $M_{5-7}—M_{6-7}$ )	.5386 (direct)	.9426 ( $M_{6-8}—M_{7-7}$ )
	? ( $M_{3-8}—M_{4-8}$ )	.7972 ( $M_{4-8}—M_{5-8}$ )	.7292 ( $M_{5-8}—M_{6-8}$ )	.7248 ( $M_{6-8}—M_{7-8}$ )	.7564 (direct)
	1.1949 (direct)	.5967 ( $M_{5-3}—M_{4-3}$ )	.7127 ( $M_{6-3}—M_{5-3}$ )	.0995 ( $M_{7-3}—M_{6-3}$ )	? ( $M_{8-3}—M_{7-3}$ )
	1.0575 ( $M_{5-3}—M_{5-4}$ )	.7341 (direct)	.9406 ( $M_{6-4}—M_{5-4}$ )	.3613 ( $M_{7-4}—M_{6-4}$ )	.4359 ( $M_{8-4}—M_{7-4}$ )
	.8296 ( $M_{6-3}—M_{6-4}$ )	.9406 ( $M_{6-4}—M_{6-5}$ )	1.0451 (direct)	.4645 ( $M_{7-5}—M_{6-5}$ )	.5101 ( $M_{8-5}—M_{7-5}$ )
	.5678 ( $M_{7-3}—M_{7-4}$ )	.5264 ( $M_{7-4}—M_{7-5}$ )	.8510 ( $M_{7-5}—M_{7-6}$ )	.5386 (direct)	.7838 ( $M_{8-6}—M_{7-6}$ )
	? ( $M_{8-3}—M_{8-4}$ )	.4522 ( $M_{8-4}—M_{8-5}$ )	.5773 ( $M_{8-5}—M_{8-6}$ )	.8074 ( $M_{8-6}—M_{8-7}$ )	.6350 (direct)
Average..	1.1479	.7340	.8443	.5359	.6858
Weighted Average	1.2008	.7483	.8685	.5606	.7065

from  $M_3$  to  $M_8$  is contracted by 0.7235 P.E., an amount which is more than some grade intervals ( $M_{6-7}$  by normal dis.,  $M_{6-7}$  and  $M_{7-8}$  by modified dis.). This is an important difference.

In the matter of scaling the words, there is, as might be supposed, very little difference for the 3d grade—so little as to be quite negligible. For the 4th grade there is some difference, and for each successive higher grade the difference between

the placings of the same word by the two methods becomes greater and greater as the asymmetry of the modified curves becomes more and more pronounced.

TABLE XLIV

## COMPARISON OF AVERAGES OF MEDIAN DISTANCES BY NORMAL DISTRIBUTION AND BY MODIFIED DISTRIBUTIONS

	Normal Distribution	Modified Distributions		
	Unweighted Averages	Weighted Averages	Unweighted Averages	Weighted Averages
$M_{3-4}$ .....	1.3326	1.3505	1.1479	1.2008
$M_{4-5}$ .....	0.8471	0.8363	0.7340	0.7483
$M_{5-6}$ .....	1.0406	1.0505	0.8443	0.8685
$M_{6-7}$ .....	0.6344	0.6608	0.5359	0.5606
$M_{7-8}$ .....	0.9201	0.9101	0.6858	0.7065

Table XLV compares the deviations from grade medians of the words of the Preferred List by Normal Distribution and by Modified Distributions. Figs. 43 to 47 give the same facts in graphic form. Words spelled by 50 per cent of pupils are of course always at 0. Words spelled by more than 50 per cent of pupils do not deviate from the median as much by modified as by normal distribution. The same is true of those spelled by less than 50 per cent of pupils. The easier a word is and the harder a word is, the greater, accordingly, is the difference in placing. The effect therefore of the modified distributions is to shorten the range of the grade scales. In using the scales, especially for pupils of the higher grades, all differences in ability between individuals or groups would tend to be decreased. It seems likely that these differences are in reality more nearly what the modified distributions show them to be. The wide range of the normal curve especially when its spread is assumed to be the same for all grades would seem to extend too far, particularly towards the low end. On the other hand, it should be said that for the words used in our scale the normal distribution gives results that are, practically speaking, satisfactory for grade scales.

TABLE XLV  
COMPARISON OF DEVIATIONS FROM GRADE MEDIAN OF WORDS OF PREFERRED LIST ACCORDING TO NORMAL AND MODIFIED DISTRIBUTION. FIGURES 43 TO 47

Word No.	Word	3d Grade				4th Grade				5th Grade				6th Grade				7th Grade				8th Grade				
		$\bar{X}$ from Grade		Correct P.E. Median		$\bar{X}$ from Grade		Correct P.E. Median		$\bar{X}$ from Grade		Correct P.E. Median		$\bar{X}$ from Grade		Correct P.E. Median		$\bar{X}$ from Grade		Correct P.E. Median		$\bar{X}$ from Grade		Correct P.E. Median		
		Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	Nor. Dis.	Mod. Dis.	
1 even...		59	—	327	79	—1,196	—1,108	89	—1,819	—1,521	93	—2,188	—1,757	97	—2,016	—2,789	93	—2,016	—2,789	97	—2,016	—2,789	93	—2,016	—2,789	97
2 lesson...		59	—	492	72	—864	—811	83	—1,415	—1,200	91	—1,988	—1,612	94	—2,305	—1,800	96	—2,597	—1,916	94	—2,597	—1,916	96	—2,597	—1,916	94
3 only...		65	—	571	75	—1,000	—936	89	—1,819	—1,521	95	—2,339	—1,933	97	—2,789	—2,035	99	—3,450	—2,310	96	—3,450	—2,310	99	—3,450	—2,310	96
4 smoke...		46	—	149	69	—1,44	—69	65	—1,537	—1,299	94	—2,305	—1,839	96	—2,597	—1,900	97	—2,305	—1,839	96	—2,305	—1,839	97	—2,305	—1,839	96
5 front...		51	—	0.37	72	—.864	—.811	80	—1,248	—1,064	90	—1,900	—1,547	94	—2,305	—1,800	97	—2,305	—1,800	97	—2,305	—1,800	97	—2,305	—1,800	97
6 sure...		47	+	112	44	+.108	55	—187	—180	69	—735	—634	78	—1,145	—958	89	—1,819	—1,454	94	—2,305	—1,753	94	—2,305	—1,753	94	
7 pear...		31	+	735	72	+.721	.422	+.299	+.286	58	—2,99	—2,633	72	—1,864	—1,728	81	—1,302	—1,048	94	—2,305	—1,753	94	—2,305	—1,753	94	
8 bought...		40	+	376	65	+.368	.65	—544	—544	79	—1,196	—1,020	91	—1,688	—1,612	94	—2,305	—1,800	96	—2,597	—1,916	94	—2,597	—1,916	96	
9 another...		36	+	531	43	+.521	.43	+.261	+.249	78	—1,145	—977	86	—1,602	—1,319	94	—2,305	—1,800	96	—2,597	—1,916	94	—2,597	—1,916	96	
10 forty...		49	+	.037	+.036	+.036	62	—.453	—.433	65	—.571	—.498	72	—.864	—.728	83	—1,415	—1,139	87	—1,670	—1,339	87	—1,670	—1,339	87	
11 pretty...		45	+	.187	+.181	67	—652	—619	76	—1,047	—894	90	—1,900	—1,547	90	—1,900	—1,515	94	—2,305	—1,753	94	—2,305	—1,753	94		
12 wear...		35	+	.360	49	+.357	+.032	61	—414	—361	74	—554	—503	84	—1,476	—1,793	82	—1,683	—1,683	82	—1,683	—1,683	82			
13 button...		32	+	.693	.677	+.693	.677	—.074	—.074	61	—414	—361	73	—509	—576	84	—1,476	—1,793	82	—1,683	—1,683	82	—1,683	—1,683	82	
14 minute...		26	+	.954	+.937	38	+.453	+.434	62	—453	—453	77	—1,096	—917	86	—1,602	—1,287	92	—2,016	—1,618	92	—2,016	—1,618	92		
15 cousin...		19	+	1.302	+.279	47	+.112	+.103	69	—735	—634	89	—1,819	—1,486	89	—1,819	—1,454	95	—2,439	—1,829	95	—2,439	—1,829	95		
16 nais...		43	+	.261	+.319	58	—.299	—.286	71	—820	—705	87	—1,670	—1,373	92	—2,083	—1,648	96	—2,397	—1,916	96	—2,397	—1,916	96		
17 janitor...		19	+	1.302	+.279	42	+.299	+.286	58	—299	—263	81	—1,302	—1,083	81	—1,302	—1,048	90	—1,900	—1,497	90	—1,900	—1,497	90		
18 saucer...		11	+	.819	+.879	29	+.909	+.920	47	—299	—272	58	—299	—257	79	—1,196	—960	81	—1,302	—1,048	90	—1,900	—1,497	90		
19 stomping...		27	+	.909	+.893	39	+.414	+.397	52	—187	—164	71	—224	—202	76	—1,047	—833	84	—1,475	—1,198	84	—1,475	—1,198	84		
20 sword...		13	+	1.670	+.647	46	+.149	+.139	57	—261	—230	78	—1,145	—955	86	—1,602	—1,287	93	—2,016	—1,618	93	—2,016	—1,618	93		
21 freeze...		29	+	.820	+.806	46	+.149	+.139	68	—695	—599	83	—1,415	—1,173	86	—1,602	—1,287	94	—2,305	—1,753	94	—2,305	—1,753	94		
22 touch...		45	+	.187	+.181	55	—.074	—.074	60	—376	—328	81	—1,302	—1,083	84	—1,475	—1,197	83	—2,188	—1,683	83	—2,188	—1,683	83		
23 whistle...		22	+	1.145	+.125	55	—.187	—.180	56	—224	—197	64	—531	—450	75	—1,047	—800	85	—1,537	—1,243	85	—1,537	—1,243	85		
24 carriage...		13	+	1.670	+.1647	40	+.376	+.360	50	—.000	—.000	67	—652	—550	81	—1,302	—1,048	85	—2,305	—1,753	85	—2,305	—1,753	85		
25 nor...		63	—	.492	—.477	61	—.414	—.396	65	—571	—498	68	—693	—585	65	—1,046	—877	94	—2,305	—1,753	94	—2,305	—1,753	94		

TABLE XLV—(Continued)  
 COMPARISON OF DEVIATIONS FROM GRADE MEDIAN OF WORDS OF PREFERENCE  
 DISTRIBUTION. FIGURES 43 TO

FIG. 43. 4th grade, Table XLV.

FIG. 44. 5th grade, Table XLV.

Fig. 45. 6th grade, Table XLV. Words 31 and 39 are omitted from Fig. 45. They occupy nearly the same positions by both scalings, 31 at about +55 and 39 at about +100.

280	-260	-240	-220	-200	-180	-160	-140	-120	-100	-80	-60	-40	-20	0	+20	+40
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Normal Dis.	Dis.															
40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56

Modified	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Dis.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57

FIG. 46. 7th grade, Table XLV. Word 39 is omitted from the scale of Fig. 46. It stands at +78 on the 'Normal' scale and at +65 on the 'Modified' scale.

Normal	-340	-320	-300	-280	-260	-240	-220	-200	-180	-160	-140	-120	-100	-80		
Dis.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Dis.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Dis.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Modified	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Dis.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Dis.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57

FIG. 47. 8th grade, Table XLV. Words 31 and 39 are omitted from the scale of Fig. 47. 31 stands at -26 and -24, 39 stands at +26 and +19, on the 'Normal' and 'Modified' scales respectively.

Table XLVI and Fig. 48 show a comparison for all grades combined. The same shortening of the range is evident but, whereas the contraction in the grade scales was more pronounced at the low ends, it is now in the general scale more

TABLE XLVI

THE AVERAGE POSITION OF EACH WORD ACCORDING TO NORMAL DISTRIBUTION AND ACCORDING TO MODIFIED DISTRIBUTION. POINT OF REFERENCE IS 3D GRADE MEDIAN. SEE FIG. 48

Word No.	Word	Average Position		Word No.	Word	Average Position	
		Normal Distribution	Modified Distribution			Normal Distribution	Modified Distribution
1	even.....	.699	.753	26	already.....	2.699	2.305
2	lesson.....	1.135	1.018	27	beginning...	2.917	2.525
3	only.....	.569	.604	28	chicken.....	.897	.872
4	smoke.....	.835	.831	29	choose.....	2.502	2.143
5	front.....	1.057	.949	30	circus.....	2.141	1.872
6	sure.....	1.568	1.349	31	grease.....	3.294	2.838
7	pear.....	1.958	1.697	32	pigeons.....	2.739	2.378
8	bought.....	1.169	1.057	33	quarrel.....	2.069	1.816
9	another.....	1.078	1.287	34	saucy.....	2.666	2.294
10	forty.....	1.758	1.477	35	tailor.....	1.866	1.579
11	pretty.....	1.311	1.137	36	telegram....	2.549	2.204
12	wear.....	1.844	1.587	37	telephone...	2.413	2.101
13	button.....	2.026	1.724	38	tobacco....	1.988	1.767
14	minute.....	1.943	1.687	39	too.....	3.491	2.998
15	cousin.....	1.681	1.491	40	towel.....	1.978	1.718
16	nails.....	1.379	1.226	41	Tuesday....	1.550	1.313
17	janitor.....	2.047	1.773	42	tying.....	1.870	1.578
18	saucer.....	2.604	2.256	43	whole.....	2.018	1.751
19	stopping.....	2.213	1.894	44	against.....	2.106	1.847
20	sword.....	2.185	1.766	45	answer.....	1.594	1.425
21	freeze.....	1.740	1.517	46	butcher....	1.473	1.308
22	touch.....	1.709	1.465	47	guess.....	2.363	2.038
23	whistle.....	2.193	1.870	48	instead.....	1.756	1.517
24	carriage.....	2.340	2.022	49	raise.....	1.652	1.456
25	nor.....	1.652	1.397	50	beautiful...	1.682	1.519

evident at the high end. There are also differences in arrangement, as there could not be in the grade scales. If two words which take the same position on the normal scale by ratings markedly different in upper and lower grades, but balancing each other in the aggregate, these words would not take the same position on the modified scale. The one which had

Fig. 48. General Scale, Table XLV. Words 31 and 39, at 329 and 349, are omitted from the 'Normal Dis.' scale of Fig. 48.

relatively low ratings in the lower grades would take a position above the other whose ratings were relatively high in the lower grades. This is because the modified distributions in the upper grades are such that counting in from the high end more rapidly approaches the median than does counting in the same per cent of the area of the normal curve. Take for example the words 25 *nor* and 45 *answer*. Compare the per cent ratings in Table XLV. *Nor* is easy in low grades and hard in upper grades, relative to *answer*. With the same normal distribution for all grades *nor* is a little harder than *answer*. By the modified distributions it is easier. Other words may easily be selected in Fig. 48 which show differences in arrangement. It is therefore true that the use of modified forms of distribution makes a difference which is worth noting in the scaling of words. A question to be decided on the evidence of more complete testing and a wide use of these forms of distribution is whether the differences here shown to exist impair the usefulness of the scales we have previously derived. Our judgment at present is that they do not.

#### § 20. *Conclusions*

We have now certain data in hand and we may make a few general statements from them.

We have selected from a school list of about 5000 words a list for test purposes in grades 3-8 which, when put in sentences, yielded a list of 270 words. As a result of testing in two schools a selected list of 100 words was chosen and to it were added, at a later time, 18 more. These were dictated at three schools and the 100 words alone subsequently at two more schools. From the 118 were chosen two lists of 25 each. The three successive selections were made with the purpose of securing words which were easy enough in the 3d grade and hard enough in the 8th grade to afford a test in those and therefore in intermediate grades, and which showed regular increases in per cent correct from grade to grade. The two 25-word lists were then subjected to analysis and found to have high correlations between grades and between schools.

Using the entire test material and the ratings of individual pupils and assuming normal distribution and equal variability,

the differences between typical grade abilities were found and expressed as median intervals.

The 50 words which had been derived by a threefold selective process and subjected to close inspection for permanency as between grades and schools were scaled for each grade and for all grades combined. By using an "Easy 50-Word List" an expression was derived for the zero-point; and, by further testing under rigidly controlled conditions, previous grade-intervals were verified.

To fill in and extend the scale, the Rice Sentence Test was dictated and the word-scores for the Easy 50-Word List were used. It is to be understood, however, that neither of these lists was subjected to the scrutiny that was made of the Preferred List. Accordingly we cannot regard the placing of these words as very reliable.

Finally we have derived and applied tables of frequency more or less asymmetrical in character according to the amount of retention for each grade and its estimated distribution. By using them, results have been obtained which in some instances differ considerably from those obtained on the basis of a normal distribution. Such differences as appear are, we are convinced, differences in the direction of a truer representation of the facts. On the whole, however, the differences are not sufficient to impair our previous results for any practical use which is likely to be made of them.

It has become evident to us that there is a lack of knowledge of the spelling problem not only among teachers but also among those who direct their work. This is unfortunate, considering the relative definiteness of the subject and the comparative ease with which results in it may be scored. Nor is there any special consciousness of the need of more insight in this matter. Almost, if not quite, all the studies that have hitherto been made have dealt with individual performances. The behavior of words has received no attention.

It is our belief, however, that a powerful improvement in the teaching of spelling may be derived from a more critical knowledge and more accurate judgment on the part of teachers and supervisors of the material of the subject—i.e., of the words of the language. If in a list of 50 words the one word that is incontestably hardest is by more than one-fourth of a representa-

tive group of teachers judged to be the easiest, or the easiest but one, that fact in itself is a very good reason why the word is so hard. Pupils misspell it because their teachers do not realize the need of teaching it. If text-book makers disagree so widely as to put the same words in grades that are three, four, and even five years apart, it is proof of the confusion that exists as to how hard words are, and when they should be taught. There are various types of words, and each type requires different treatment. There is the type that does not need to be taught at all. There is the type which appears easy in the lower classes and (grade considered) hard in the upper classes. Such may have been prematurely taught in the lower classes. There is the type that appears to possess special difficulty for the middle grades. This is due to a constant cause—e.g., in the case of *whose*, to the learning of the use of the apostrophe in possessives. There are types of errors; there is the problem of substitution, of illegibility, and of omission.

To obtain any accurate notion of "word behavior" we must rate for words as distinct from individuals. Moreover we must give our per cent ratings thus obtained an interpretation for difficulty which takes account of the distribution of spelling ability. When we do so we shall find how unreliable percentages are as indicating differences in difficulty. We shall find, for instance, that a difference of 10 per cent between two words rated 89 and 99 means more than four times as great a difference in difficulty as is that between two words rated at 45 and 55, although the percentage difference is in both cases the same. Table XLVII (See appendix) is a ready reckoner for the conversion of percentages into units that take account of the form of distribution, assuming it to be 'Normal.'

If this study does no more than show the need of word criticism and indicate a method, it may be worth while. Every school affords a place and every day a time at which something may be done to help throw light on the nature of the material we deal with in spelling. All such work should be collected and made generally available. If teachers, principals, or superintendents who have made or who hereafter make a study of the difficulty of words, will submit them to the author of this study, the data will be gratefully received and utilized to disseminate a larger and more accurate knowledge.

## APPENDIX

### I. LIST OF AUTHORS AND TITLES SPECIFICALLY REFERRED TO IN THE TEXT

THORNDIKE, E. L. ('10). Handwriting. *Teachers College Record*, Vol. XI, No. 2.

HILLEGAS, MILO B. ('12). A Scale for the Measurement of Quality in English Composition by Young People. *Teachers College Record*, Vol. XIII, No. 4.

RICE, J. M. ('97). The Futility of the Spelling Grind. *Forum*, Vol. XXIII, pp. 163-172; 409-419.

THORNDIKE, E. L. ('13). An Introduction to the Theory of Mental and Social Measurements. Second Edition. Teachers College, New York.

CORNMAN, O. P. ('02). Spelling in the Elementary School. Ginn and Co., New York.

WALLIN, J. E. WALLACE, ('11). Spelling Efficiency in Relation to Age, Grade, and Sex, and the Question of Transfer. Warwick and York, Baltimore.

PEARSON, HENRY C. ('12). Experimental Studies in the Teaching of Spelling. *Teachers College Record*, Vol. XIII, No. 1.

SPEARMAN, C. ('06). 'Foot-rule' for Measuring Correlation. *Brit. Journ. of Psych.*, Vol. II, Pt. I, July, 1906.

BROWN, WILLIAM, ('11). The Essentials of Mental Measurement. Putnam, New York.

WHIPPLE, GUY MONTROSE. ('10). Manual of Mental and Physical Tests. Warwick and York, Baltimore.

KLEIN, LINUS W. ('12). A Study in the Psychology of Spelling. *Journ. of Ed. Psych.*, Vol. III, No. 7.

THORNDIKE, E. L. ('07). The Elimination of Pupils from School. Bureau of Education, Bulletin No. 4, 1907.

AYRES, LEONARD P. ('09). Laggards in our Schools. Russell Sage Foundation, New York.

THORNDIKE, E. L. ('10). Promotion, Retardation, and Elimination. *Psych. Clinic*, Vol. III, No. 8 and 9.

STRAYER, GEORGE DRAYTON ('11). Age and Grade Census of Schools and Colleges. Bureau of Education, Bulletin No. 5, 1911.

YULE, G. UDNEY ('11). An Introduction to the Theory of Statistics. Lippincott, Philadelphia.

## II. LISTS REFERRED TO IN THE TEXT AND USED IN THE SCALES

Preferred List <i>First</i>	Easy 50-Word List	Rice Sentence List
1. even	1. you	1. running
2. lesson	2. will	2. slipped
3. only	3. hear	3. listened
4. smoke	4. him	4. queer
5. front	5. coming	5. speech
6. sure	6. he	6. believe
7. pear	7. is	7. weather
8. bought	8. on	8. changeable
9. another	9. the	9. whistling
10. forty	10. road	10. frightened
11. pretty	11. and	11. always
12. wear	12. almost	12. changing
13. button	13. sure	13. chain
14. minute	14. to	14. loose
15. cousin	15. pass	15. baking
16. nails	16. in	16. piece
17. janitor	17. front	17. receive
18. saucer	18. of	18. laughter
19. stopping	19. me	19. distance
20. sword	20. I	20. choose
21. freeze	21. send	21. strange
22. touch	22. for	22. picture
23. whistle	23. every	23. because
24. carriage	24. day	24. thought
25. nor	25. go	25. purpose
<i>Second</i>		
26. already	27. school	27. lose
27. beginning	28. but	28. almanac
28. chicken	29. do	29. neighbor
29. choose	30. not	30. writing
30. circus	31. touch	31. language
31. grease	32. table	32. careful
32. pigeons	33. also	33. enough
33. quarrel	34. has	34. necessary
34. saucy	35. only	35. waiting
35. tailor	36. one	36. disappoint
36. telegram	37. pair	37. often
37. telephone	38. shoes	38. covered
38. tobacco	39. they	39. mixture
39. too	40. are	40. getting
40. towel	41. at	41. better
41. Tuesday	42. all	42. feather
42. tying	43. pretty	43. light
43. whole	44. no	
44. against	45. man	
45. answer	46. ought	
46. butcher	47. steal	
47. guess	48. even	
48. instead	49. a	
49. raise	50. penny	
50. beautiful		

### III. MEMORANDUM ON THE METHOD OF COMPUTING WITH MODIFIED FREQUENCY TABLES. (TABLES XXXVI-XLI.)

1. *Derivation of Median Intervals.* Table XLII, lines 4 and 5, gives for the 4th grade the number and per cent of pupils who equal or exceed the median pupil of each of the other grades. In line 6 the corresponding P.E. values are shown. These are obtained by using Table XXXVII as follows: (a) Since 80.9% of 4th-grade pupils surpass the median 3d-grade pupil, deduct 8090 cases from the high end of the 4th-grade distribution. Since there are 5236.32 above  $M_{4(\text{nor. dis.})}$ , 2853.68 more must be taken, extending to a point which is 1.1079 P.E. below  $M_{4(\text{nor. dis.})}$ . But  $M_{4(\text{nor. dis.})}$  is itself .087 P.E. below  $M_{4(\text{mod. dis.})}$ . Correcting for this, we have 1.1049 P.E. below  $M_{4(\text{mod. dis.})}$ . ( $1.1079 - .087 = 1.1049$ ) This is the first entry in line 6 of Table XLII. (b) Deduct 3130 from 5236.32, leaving 2106.32. By interpolation this corresponds to +.7835 P.E. Subtracting .087 P.E. as before, we have +.6965, the second entry in line 6 of Table XLII. (c) 5236.32 less 1110 gives 4126.32, corresponding to +1.8486 P.E. Again subtracting .087 P.E., we have +1.7616 P.E., which is the third entry in line 6, Table XLII.

2. *Scaling the Words.* For "even," Table XLV, columns headed "Modified Distributions," the figures are derived as follows, using for each grade its proper frequency table: *Third Grade.* 59% correct. Count out the 5900 highest cases. There are 5141.7 above  $M_{3(\text{nor. dis.})}$ . We must, therefore, take 758.3 cases below that point. This brings us to —.276 P.E. Subtracting (algebraically) .051 P.E., in order to refer this to  $M_{3(\text{mod. dis.})}$ , we have —.327 P.E., as in Table XLV. *Fourth Grade.* 79% correct. Counting out 7900 cases from the high end, we take all the "highs" and 2663.32 of the "lows," reaching as far as —1.0212 P.E. But  $M_{4(\text{mod. dis.})}$  is .087 P.E. above  $M_{4(\text{nor. dis.})}$ . Subtracting this amount, we have —1.108 P.E. as in Table XLV. *Fifth Grade.* When percentages are high, it is generally easier to count out their complements from the *low* end. "Even" is in this grade 89% correct. We may therefore count 8900 cases from the high end or 1100 from the low end. In either case we reach the 3245th case of the "lows," which corresponds to —1.306 P.E. Correcting for the deflection of the median from its "normal" position (.215 P.E.), we have —1.521 P.E. as given. *Sixth Grade.* 3696 — 700 = 2996. The 2996th case corresponds to —1.339 P.E. Median displacement = .418 P.E. Subtracting from —1.339 P.E., we have —1.757 P.E., as given. The 7th and 8th grade positions are derived in the same way, care being taken to use the proper grade table of frequency in each case.

Table XLVI. The average position for each word as given in the column headed "Modified Distributions" was computed as follows: Add to the P.E. value of "even" for each grade (Table XLV) the distance which the grade median is above the 3rd-grade median. From Table XLII these distances are shown to be:  $M_{3-4}$ , 1.148 P.E.;  $M_{2-3}$ , 1.882 P.E.;  $M_{3-5}$ , 2.726 P.E.;  $M_{3-7}$ , 3.262 P.E.;  $M_{3-8}$ , 3.948 P.E. Adding these values to those of Table XLV, beginning with the 4th grade and writing the 3rd grade as given, we have the following P.E. values: —.327, +.040, +.361, +.969, +1.541, and +1.932. The average of these is +.753 P.E., as given for the word "even" in Table XLVI. The average positions of the remaining words were computed in the same way.

IV. TABLE XLVII—P.E. VALUES CORRESPONDING TO GIVEN PER CENTS OF THE NORMAL SURFACE OF FREQUENCY, PER CENTS BEING TAKEN FROM THE MEDIAN

	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	.000	.004	.007	.011	.015	.019	.022	.026	.030	.033
1	.037	.041	.044	.048	.052	.056	.059	.063	.067	.071
2	.074	.078	.082	.085	.089	.093	.097	.100	.104	.108
3	.112	.115	.119	.123	.127	.130	.134	.138	.141	.145
4	.149	.153	.156	.160	.164	.168	.172	.175	.179	.183
5	.187	.190	.194	.198	.201	.205	.209	.213	.216	.220
6	.224	.228	.231	.235	.239	.243	.246	.250	.254	.258
7	.261	.265	.269	.273	.277	.280	.284	.288	.292	.296
8	.299	.303	.307	.311	.315	.318	.322	.326	.330	.334
9	.337	.341	.345	.349	.353	.357	.360	.364	.368	.372
10	.376	.380	.383	.387	.391	.395	.399	.403	.407	.410
11	.414	.418	.422	.426	.430	.434	.437	.441	.445	.449
12	.453	.457	.461	.464	.468	.472	.476	.480	.484	.489
13	.492	.496	.500	.504	.508	.512	.516	.519	.523	.527
14	.531	.535	.539	.543	.547	.551	.555	.559	.563	.567
15	.571	.575	.579	.583	.588	.592	.596	.600	.603	.608
16	.612	.616	.620	.624	.628	.632	.636	.640	.644	.648
17	.652	.656	.660	.665	.669	.673	.677	.681	.685	.689
18	.693	.698	.702	.706	.710	.714	.719	.723	.727	.731
19	.735	.740	.744	.748	.752	.756	.761	.765	.769	.773
20	.778	.782	.786	.790	.795	.799	.803	.807	.812	.816
21	.820	.825	.829	.834	.838	.842	.847	.851	.855	.860
22	.864	.869	.873	.878	.882	.886	.891	.895	.900	.904
23	.909	.913	.918	.922	.927	.931	.936	.940	.945	.949
24	.954	.958	.963	.968	.972	.977	.982	.986	.991	.996
25	1.000	1.005	1.009	1.014	1.019	1.024	1.028	1.033	1.038	1.042
26	1.047	1.052	1.057	1.062	1.067	1.071	1.076	1.081	1.086	1.091
27	1.096	1.101	1.105	1.110	1.115	1.120	1.125	1.130	1.135	1.140
28	1.145	1.150	1.155	1.160	1.165	1.170	1.176	1.181	1.186	1.191
29	1.196	1.201	1.206	1.211	1.217	1.222	1.227	1.232	1.238	1.243
30	1.248	1.253	1.259	1.264	1.269	1.275	1.279	1.286	1.291	1.296
31	1.302	1.307	1.313	1.318	1.324	1.329	1.335	1.340	1.346	1.351
32	1.357	1.363	1.368	1.374	1.380	1.386	1.391	1.397	1.403	1.409
33	1.415	1.421	1.427	1.432	1.438	1.444	1.450	1.456	1.462	1.469
34	1.475	1.481	1.487	1.493	1.499	1.506	1.512	1.518	1.524	1.531
35	1.537	1.543	1.549	1.556	1.563	1.569	1.576	1.582	1.589	1.595
36	1.602	1.609	1.616	1.622	1.629	1.636	1.643	1.649	1.656	1.663
37	1.670	1.677	1.685	1.692	1.699	1.706	1.713	1.720	1.728	1.735
38	1.742	1.749	1.757	1.765	1.772	1.780	1.788	1.795	1.803	1.811
39	1.819	1.827	1.835	1.843	1.851	1.859	1.867	1.875	1.884	1.892
40	1.900	1.909	1.918	1.926	1.935	1.944	1.953	1.962	1.971	1.979
41	1.988	1.997	2.007	2.016	2.026	2.035	2.044	2.054	2.064	2.074
42	2.083	2.093	2.103	2.114	2.124	2.134	2.145	2.155	2.166	2.177
43	2.188	2.199	2.211	2.222	2.234	2.245	2.257	2.269	2.281	2.293
44	2.305	2.318	2.331	2.344	2.357	2.370	2.384	2.397	2.411	2.425
45	2.439	2.453	2.468	2.483	2.498	2.514	2.530	2.546	2.562	2.579
46	2.597	2.614	2.631	2.648	2.667	2.686	2.706	2.726	2.746	2.767
47	2.789	2.811	2.834	2.857	2.881	2.905	2.932	2.958	2.986	3.015
48	3.044	3.077	3.111	3.146	3.182	3.219	3.258	3.300	3.346	3.395
49	3.450	3.506	3.571	3.643	3.725	3.820	3.938	4.083	4.275	4.600



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